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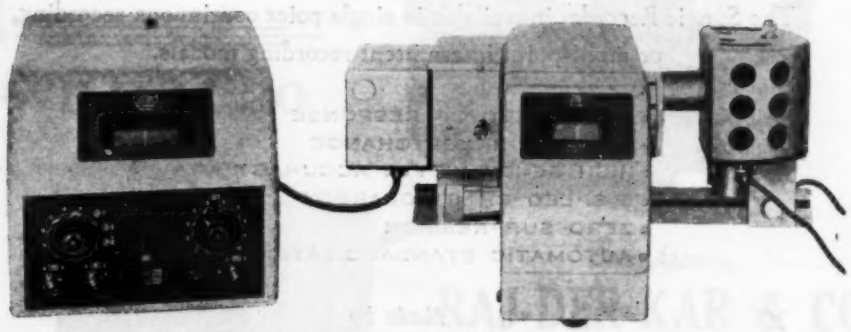

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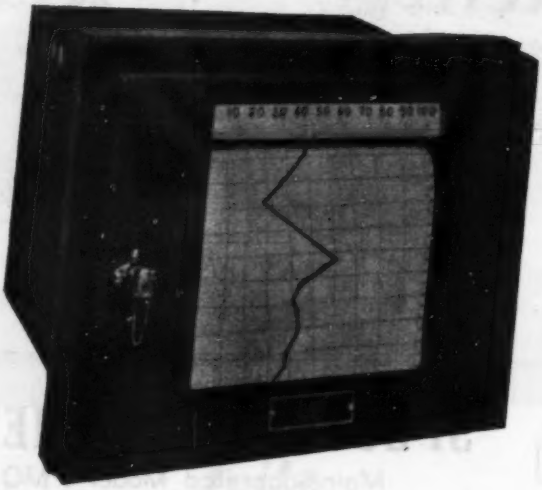

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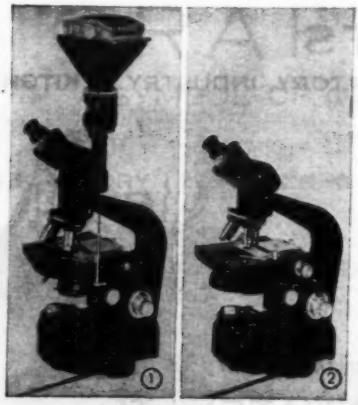

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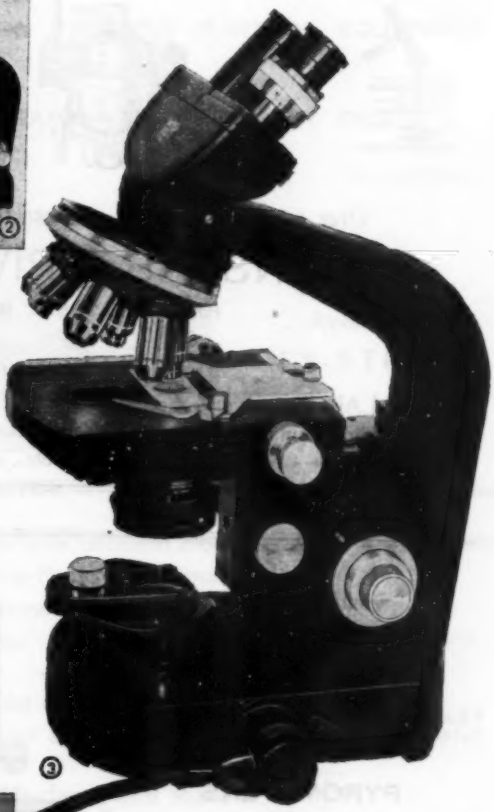

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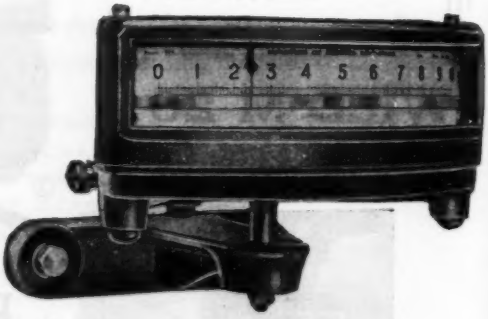

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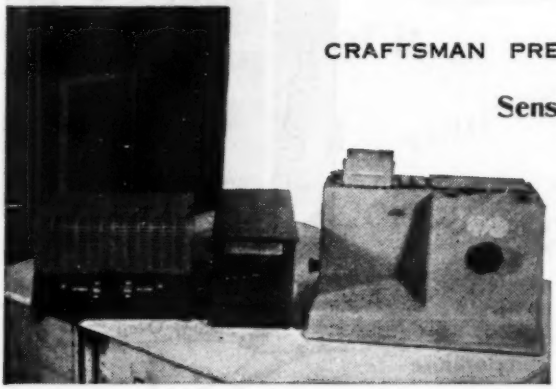

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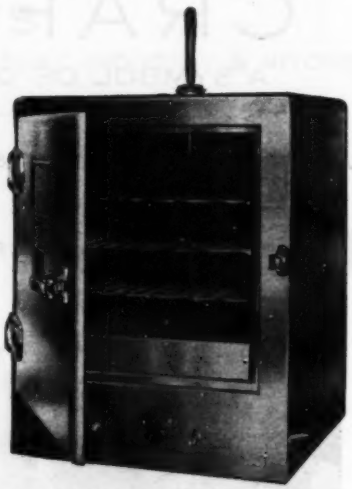

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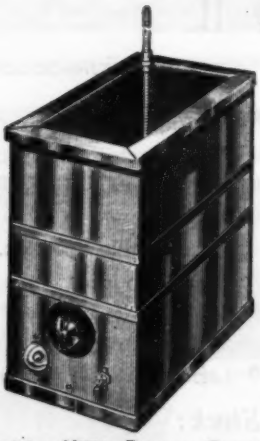

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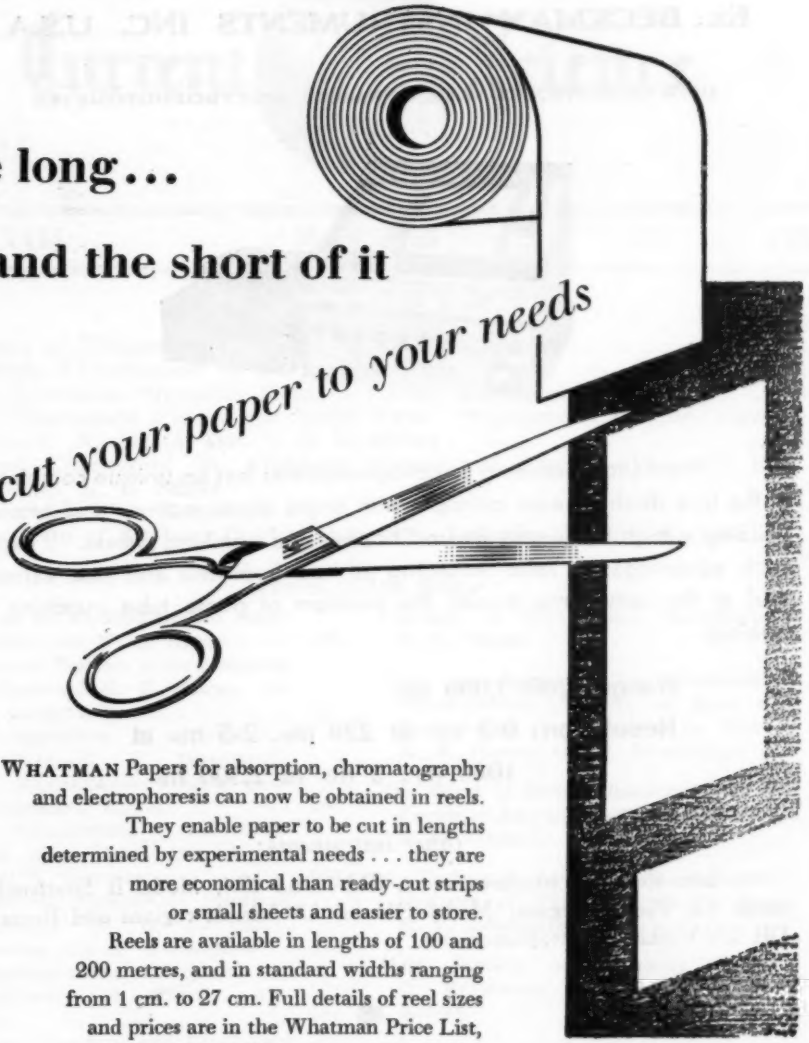

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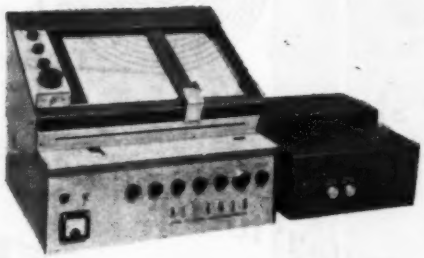

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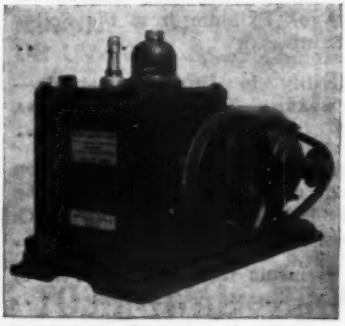

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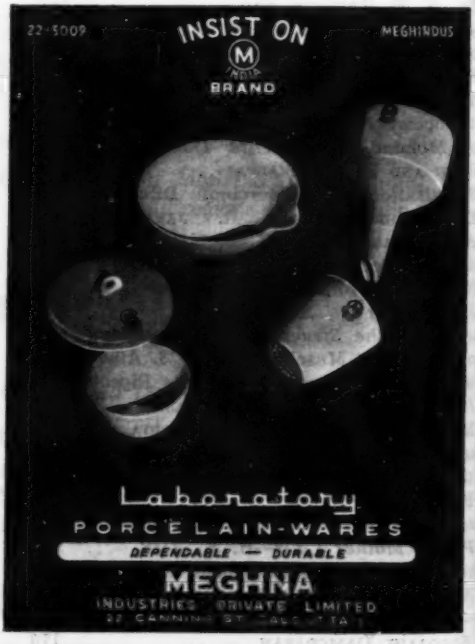

APPLICATIONS OF ULTRASONIC VIBRATIONS*

E. G. RICHARDSON

Professor of Acoustics, University of Durham, England

THESE vibrations though possessing the same physical characteristics as sounds have frequencies so high that they fall outside the range of pitch to which the human ear is susceptible. It is well known that as the pitch of a sound goes up it eventually becomes inaudible when its frequency is about 20,000 vibrations per second. There is no theoretical upper limit to the ultrasonic frequency though with existing means, experiments are limited to the range 20 kilocycles to 50 megacycles per second.

Most of the applications to which I shall refer make use of sources working on the piezo-electric or the magneto-striction principle. The former is an adaptation of an effect discovered by the brothers Curie, *i.e.*, that certain crystals, when compressed along one of their axes, develop charges on these or other faces and *vice versa*. If now an alternating potential difference is applied across one pair of faces, compressions and contractions of the crystal follow at the same frequency. The effect will be most manifest when the exciting frequency corresponds to one of the natural frequencies of vibration of the crystal, determined by its length in the particular direction of expansion and contraction, and the velocity of sound in the material. Such a piezo-electric resonator was first realised by Langevin in 1917; he used slabs of quartz and applied the necessary potential difference through a thermionic valve oscillator.

The substances most commonly used as sources in this way are quartz, Rochelle salt and tourmaline. They are cut into discs or slabs in such directions that electrodes may be applied to carry potential in the direction of one of their crystalline axes. In the case of the slabs, the electrodes are cemented to the top and bottom and the extensions and contractions take place along the greatest dimension. The discs are usually cut so that the motion takes place in the same direction as the applied alternating potential, namely, perpendicular to the flat face (in concertina fashion). The natural frequency is inversely related to the thickness of the disc, about 2·5 cm. for 100,000 c./sec.; 2·5 mm. for 1,000,000 c./sec. in quartz.

The magneto-striction oscillation is induced by a current of the requisite frequency through a coil wrapped round an iron or nickel rod, causing variations in length as the magnetic field strength alternates.

Either of these latter types of source is capable of sending out ultrasonic waves into the fluid medium in which it is placed, of sufficient energy for most laboratory experiments. In certain applications, however, a larger radiating surface is required than can be obtained from the face of a single crystal or nickel rod. In order to achieve this, Langevin constructed a sort of sandwich consisting of a large number of little slabs side-by-side and all having their axes of vibration parallel between two metal slabs to act as electrodes. By the concourse of crystals vibrating together the lower plate was made to move relative to the top one, and thus a large radiating area was added to the source, when working into water. It is also possible to construct a bowl-shaped oscillator made of a mosaic of crystals so that a large ultrasonic intensity is produced at the focus (Fig. 1).

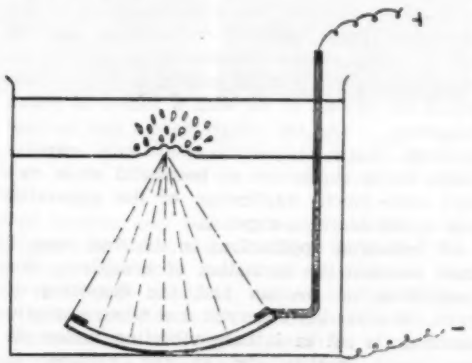

FIG. 1. Bowl type of ultrasonic source focussing sound energy at the surface of a liquid.

In the case of the magneto-striction oscillators a number of rings threaded together have coils wrapped round them so that they all expand and contract round their circumferences in unison. The energy is received on the surface of a metal horn, so that the radial oscillations are turned through a right angle and

* Based on lectures given at a number of Indian Universities in December 1957 and January 1958.

sent out from the horn in the form of a beam (Fig. 2).

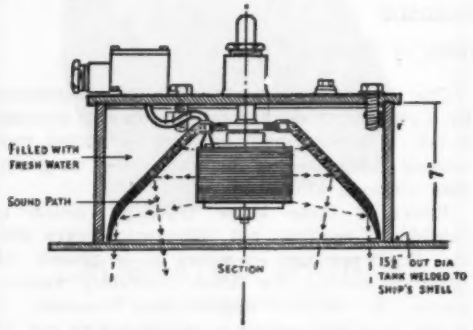

FIG. 2. Magneto-striction source reflecting energy from a metal horn into a liquid.

The applications of ultrasonics on a larger scale fall under two heads. There are those which make use of the energy of the high frequency vibration which can be induced by their aid to agitate various materials, both inorganic and organic. Others use the principle of echo-detection by which a beam of ultrasonics is made to pulse towards a suspected obstacle, to be reflected there and caught on a suitably-tuned receiver. In this latter use a source of high frequency is essential, as we shall see, but many of the perturbation methods could be equally well carried out with a source of lower frequency. The advantage here of the ultrasonic source is in its compactness and the fact that the intense vibrational energy can be concentrated into a small region, a thing which would be difficult to do with a source of lower frequency. On the other hand, this feature prevents many successful small-scale experiments being copied on an industrial scale, except with much duplication of the apparatus and at considerable expense.

Of industrial applications in the first class, I shall mention the formation of emulsions, the coagulation of smokes and the degassing of melts. It is readily observed that when a quartz oscillator is set in intense vibration under oil the liquid, particularly at the surface, is set into violent agitation; in fact, the liquid may rise above the surface in a fountain which disperses fine oil drops as a foam above it (Fig. 3). Place a lighter liquid above the one in which the oscillator is working and you disperse one into the other as an emulsion. This process is sometimes used in the manufacture of photographic emulsions, as it is found that a finer grain results. If an ultrasonic emitter is placed at the base of a glass chimney to which tobacco smoke or a water mist has been disseminated, the particles are agitated and brought into collision more frequently than otherwise. This causes coalescence and the larger particles so formed soon drop to the floor of the chimney. It is necessary that the final resting place of the liquid or solid forming the smoke shall be screened from the radiation, otherwise a certain amount of re-dispersal results.

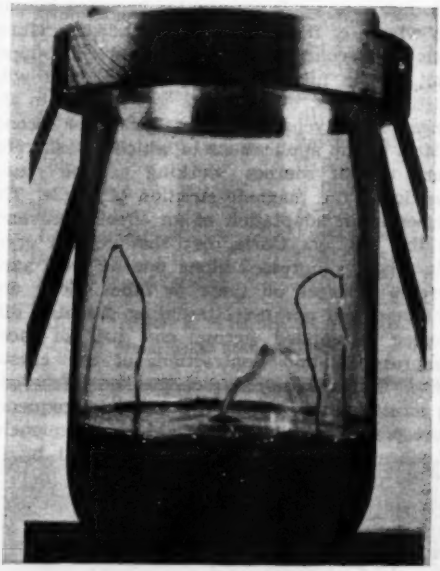

FIG. 3. Bowl type of source producing a fountain at the surface of a liquid.

Gas bubbles suspended in molten metals may similarly be brought to the top and out of suspension. In casting molten metal, such bubbles may be occluded and serve to weaken the structure after solidification. It is also possible to clean textiles immersed in water, as in laundering, by agitating the water ultrasonically. This removes dirt and fat.

For some years it has been known that it is possible to tin aluminium and its alloys by subjecting their surface to the action of intense ultrasonic vibration at the same time as molten solder is applied. It is now established that the process is one of removing the oxide skin by cavitation erosion. When, however, the experiment was repeated with an ambient pressure of 4 atmospheres, tinning was completely prevented. Since the increased pressure can have had only a negligible effect on any factor other

than cavitation, this seems convincing evidence of the essential part played by the latter.

Aluminium is known to have a low resistance to cavitation erosion, even in water, so it is not surprising that collapsing voids in molten solder will be able to disrupt the surface, exposing the aluminium underneath for alloying with the metal which is impinging violently against it in the very action of cavitation. We can expect, moreover, that the usefulness of the ultrasonic technique for tinning different 'difficult' metals will be related to their susceptibility to cavitation erosion.

The detection of underwater obstructions by the echoes which they send back to a ship was the first application of ultrasonics and the *raison d'être* of the Langevin quartz 'sandwich'. Although too late for much use in the First World War, the apparatus under the name of Asdic was of great service for detecting submarines in the Second. It is well known that between the two wars, a device on the same principle using electromagnetic waves was developed, under the name of radio-location or radar, to detect obstacles in the air. Owing to the great absorption, which the latter suffer in water, ultrasonic waves must be used in the sea. It is interesting to note that high-frequency sound waves were suggested in a patent by Dr. L. F. Richardson for the detection of the submerged portion of icebergs after the *Titanic* disaster, but the means of producing them in sufficient power were wanting until Langevin's invention.

Unfortunately, the similar elastic properties of ice and water prevent a good echo being obtained off an iceberg, but the ultrasonic echo-sounder has now become a common piece of equipment for hydrographic surveying, both for delineating the bed of the sea when pointed downwards from the survey ship, or pointing upwards from the harbour bed to measure tidal-height or even wave height. With the former arrangement even a shoal of fishes can be detected.

Another factor which must be reckoned with is the increasing absorption which sound waves suffer in a fluid as the frequency is pushed up. This can be noticed by anyone who has used underwater listening equipment. When a hydrophone is laid at some distance from a ship the low-frequency engine noises and hull vibrations predominate. This factor combined with the diffraction we have already noted sets the optimum frequency for under-water echo sounding at about 20 kc./sec., just above the audible limit.

In use the magneto-strictive oscillator in its horn-like housing is turned either vertically downwards, if it is the sea-bed which is to be detected or roughly horizontally and scanned round in a circle by rotating the housing if, *e.g.*, submarines are being looked for, just as a radar beam is scanned round the horizon from the transmitter-*cum*-receiver aerial.

For the detection of flaws in the form of hairline cracks in metals, a system has been developed by the firm of Hughes in England in which a short train of waves is sent out and its wave form, as recorded by the receiver, noted on a cathode-ray oscillograph. They use quartz oscillators sometimes one at each end of an ingot (transmission method); sometimes on two facets of a prismatic specimen (reflection or echo-sounding method). The presence of hair-line cracks is shown in the latter method by a number of secondary echoes which reach the second quartz before the main reflection from the base of the prism (Fig. 4). Whereas

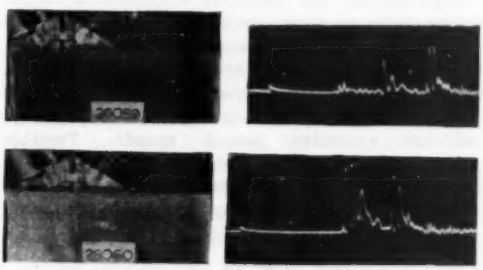

FIG. 4. Detection of flaws in a metal ingot. The echoes from these and from the base of the ingot are shown in the cathode-ray oscillograph displays on the right.

large fissures may be more readily detected by X-rays, the ultrasonic method is better for spotting these tiny cracks since it needs but the narrowest break in the continuity of the metal to give rise to a secondary reflection.

Formerly the velocity of sound in a gas was thought to be independent of frequency, the fact that the music of an open-air band is not distorted by distance being cited as proof. Soon after the discovery of ultrasonic quartz sources by P. Langevin, however, G. W. Pierce noted that at a frequency of about 100 kc./s. a rise of velocity occurred in carbon dioxide, accompanied by a considerable absorption of the energy. Following an idea which Debye had already pursued with success in explanation of the variation of dielectric constant with frequency, Herzfeld and Rice suggested that this

was an acoustic relaxation involving the transfer of translational into vibrational energy and taking time in the process. In other words, above a certain frequency there is not time for this transfer to take place and the molecules become effectively stiffer, hence the rise in velocity of propagation and the change in phase between pressure and particle velocity which results in the attenuation of the ultrasonic signal as it passed through the gas. This behaviour is characteristic of a system which possesses a single relaxation time for the transfer of translational into vibrational energy.

In the succeeding twenty-five years, similar relaxations have been discovered in other gases, though none so pronounced as in carbon dioxide. Fig. 5, for example, shows a vapour in which this rise in velocity of sound accompanied by enhanced absorption occurs at a certain value of the parameter (frequency/pressure), for it is found that the relaxation time is inversely proportional to the pressure on the gas.

The subject has received attention in recent years from workers in aerodynamics who are looking for vapours capable of being substituted for the air in supersonic wind tunnels. These should have a low velocity of sound in order that high Mach numbers may be reached without excessive tunnel speeds. Possible vapours for this purpose are the freons and the hexafluorides, and work is going on in the author's laboratory on these vapours, with such aerodynamic applications in view (*cf.* Fig. 5).

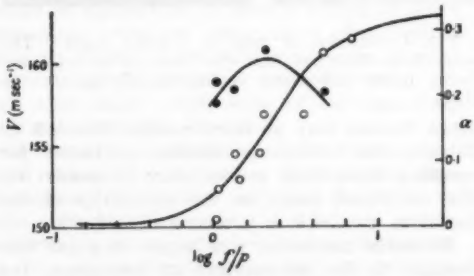

FIG. 5. Variation of velocity of sound V (o) and absorption α (o) in freon exhibited in terms of frequency/pressure.

If, as is apparent, their molecules can relax at lower frequencies than those of oxygen or nitrogen of the atmosphere (which scarcely show relaxation within yet attainable ultrasonic frequencies), then shock waves initiated in them may not properly reproduce conditions in the atmosphere. When a shock wave passes through a relaxing gas, the density does not immediately take up its new value. A photograph taken with an optical interferometer will then show (in the interference bands) the gas adjusting itself exponentially to the new conditions, instead of instantaneously (*cf.* Fig. 6, which refers to carbon dioxide).

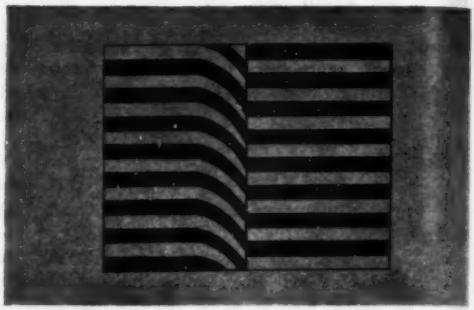

FIG. 6. Passage of shock front in carbon dioxide. The black lines are the diffraction bands seen in an optical interferometer.

In liquids, relaxations in the sense of anomalous absorption accompanied by a rise in velocity of propagation have not been definitely established since, within the limits of precision of present experimental technique, no dispersion of velocity with frequency has been established (except in acetic acid). This is not to say that the attenuation of the wave is normal in the sense that it is proportional to the kinematic viscosity of the liquid in the way that the 'classical' formula of Stokes would have it be. In fact, although in many liquids the quotient; (absorption coefficient)/(frequency)^2 is a constant as it should be (and which precludes relaxation on the simple theory), this constant is in very few cases the Stokesian one, for instance, in benzene it is 600 and in carbon disulphide 1,000 times the expected value on the basis of shear viscosity. It has been suggested by the author that this effect is connected with the ease of formation of cavitation nuclei in these liquids which have high vapour pressures. Others ascribe it to a form of compressional viscosity, peculiar to the propagation of ultrasonic energy.

The molecules of solid bodies, being more restricted in their movements, show usually a spectrum of relaxation times spread over the whole gamut. The disentanglement of these and their ascription to various causes is a major problem to the physical metallurgist and his fellow worker in high polymer studies.

This molecular friction must be related to things which can be directly measured. These are (*a*) the decrement of amplitude of forced vibrations, and (*b*) the reciprocal width of a resonance peak under forced vibration. In a number of materials available in the form of cylinders, transverse oscillations may be excited by clamping one end and attaching an iron inertia bar to the other which is then set in motion by external magnets. As the range of frequency of the experiments is raised, the investigator usually replaces flexural vibrations by torsional vibrations. It is often more convenient to vary the temperature than the frequency. In general the internal friction will fall as the temperature rises, though it rises in glass. If there is a relaxation peak in the infrasonic range it will usually shift with temperature, so that at a given temperature the substance will have a loss which represents some point on the peak.

ROCKET-FIRING CONTRIBUTION TO GEOPHYSICAL YEAR

COMPARED with the amount of attention given to satellites, the firing of 120 or so rockets as contributions to the International Geophysical Year has passed largely unnoticed. Yet a preliminary review of the scientific information obtained from 81 research rockets launched by the U.S.A. between July 1, when the I.G.Y. began, and November 30 shows that much of interest has been learnt, especially from northern and Arctic firings.

The American northern firings have been from a rocket base set up by Canada at Fort Churchill on Hudson's Bay. This is more favourably placed than might be supposed. Although no farther north than John O'Groats it is only some 900 miles from the North Magnetic Pole. It is therefore well placed for the study of those effects which are produced on the earth by the arrival of electrically charged particles from the sun; since, influenced by the magnetic field of the earth, they follow spiral paths towards the regions of the two magnetic poles. Firings within the Arctic circle were made from shipboard, using the "rockoon" method, in which the rocket is fired by radio signals from below a balloon.

Rockoon

A result of the "rockoon" firings was that "an excellent survey was made for the first time of auroral particles"—which are known to include protons, otherwise hydrogen nuclei, ejected from the sun—"and their association with actual auroræ". This is one of several points about auroræ on which there have been gaps in knowledge. In principle it should be possible to correlate the forms and development of auroræ with the distribution of incoming particles. But to do this completely, even for one area, would require a very large number of rockets.

A total of 18 "rockoons" was fired during the American Arctic cruise, and 36 in a similar operation which was carried southwards from the Pacific into Antarctic waters. The southern cruise was, however, completed too late for the present summary.

One object of firings from Fort Churchill was to explore conditions in the ionosphere during a polar radio black-out—an effect which was first established during the International Polar Year of 1932-33 through an expedition led by Prof. Sir Edward Appleton to Tromso, in Norway. Rocket measurements, made apparently by two different methods, have now confirmed that the cause of such sudden lowering of the D-region of the ionosphere—the lowest of the (normally) radio-reflecting regions of the atmosphere.

Other firings had as their object the collection of information about the pressure, temperature and density of the air above Fort Churchill. They were carried out in different months, by night as well as by day, and at heights of up to 125 miles. A general effect was to show that the density of the air at the greatest heights was much more strongly controlled by the sun than above New Mexico, where most previous research rockets have been fired. "There appear to be a latitude effect, a seasonal effect, and a strong diurnal effect; none of these effects appears at lower altitudes at Fort Churchill or at lower latitudes." Temperatures in the stratosphere were found to continue rising up to greater heights—37 miles, compared with about 30 miles—than in lower latitudes.

Another experiment is thought, provisionally, to provide the first evidence of the beginning of a sorting out of the gases of the atmosphere on the basis of density, as height is increased.

There are two grounds in this for interest. One is that a sorting out of this kind implies that the atmosphere is no longer being stirred effectively; that the limit of air movements which may be connected with weather below has been reached. The other is in relation to the past and present history of the atmosphere; since the lighter a gas is the more readily must it escape from the earth.

"ELECTRO-JET"

Evidence for such a sorting out has been sought, but not confirmed, at lower latitudes. In the First Churchill measurements, a census of the atoms and molecules present in the air at different levels was taken with a mass spectrometer. There is an element of interpretation in such measurements, admittedly. The conclusion, cautiously expressed, is that at the latitude of Fort Churchill (58° 40' N.) the gases of the atmosphere appear to be well mixed up to about 100 kilometres (about 62 miles), but that above this there is a beginning of separation under gravity.

The summary of American measurements that has been quoted covers also other forms of research. One that is of interest, and to some extent related, is an attempt to confirm from magnetic stations at ground level the existence of the so-called equatorial "electro-jet". The effects observed in magnetic storms are thought to be connected with great electric currents, of perhaps several hundred thousand amperes, circulating high in the atmosphere. Two of these currents are thought to circle the North and South Magnetic Poles. A third, round the magnetic equator, is thought to become narrowed at local noon, so that the density of current is increased, the effect at ground level being then greater.

A chain of stations has been set up in the Pacific and South America to test the reality of the "electro-jet". The data that are being collected at all stations will need to be analysed and compared before any firm conclusions are drawn. Meantime, early data from one station, Koror, in the Western Pacific—are said to show that the electro-jet exists.

EFFECT OF TERRESTRIAL MAGNETIC FIELD ON COSMIC RADIATION

THERE is an appreciable difference between the characteristics of the terrestrial magnetic field obtained, on the one hand, through the study of cosmic rays and, on the other, by the measurement of the magnetic field on the earth's surface.

This is the conclusion which the Soviet scientists have arrived at, after the initial sorting out of the findings of research done with the first Soviet artificial earth satellites, Academician Topchiev, Scientific Secretary of the Presidium of the USSR Academy of Sciences, has declared.

An analysis of the number of cosmic ray particles at different latitudes and longitudes has shown that the lines of uniform intensity of cosmic rays do not coincide with geomagnetic parallels.

A study of the measurements of the intensity and variations of the intensity of cosmic rays, done with the second Sputnik, has made it possible to determine the dependence of the number of particles on altitudes.

Academician Topchiev announced that increases of cosmic ray intensity of up to 40% had been observed in the interval altitudes of 225 to 700 kilometres. This phenomenon is believed to be mainly due to the reduction of the effect of the terrestrial magnetic field on cosmic radiation at great altitudes.

Along with this, observations have established that there are fluctuations of cosmic ray intensity which are probably associated with the state of outer space closer to earth. On one occasion a steep increase (50%) of the number of cosmic ray particles has been observed. This has, possibly, been caused by a new phenomenon, to wit, the generation of cosmic rays of very low energies on the sun which are intensely absorbed by the earth's atmosphere.

LIMITING POLARIZATION CURVES FOR RADIO WAVE PROPAGATION IN THE IONOSPHERE

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THE polarization of a radio wave propagated through the ionosphere in the presence of earth's magnetic field is usually represented by θ and ψ. If the direction of wave propagation is along the positive direction of the X-axis of a right-handed co-ordinate system and the earth's magnetic field is assumed to be in the XZ-plane, then θ is defined by $\tan\theta = -j(h_z/h_y)$ where h_y and h_z are the magnetic vectors of the wave along the Y and Z axes, and ψ is the tilt of the polarization ellipse with respect to the Z-axis. In the present communication we shall discuss the limiting values of θ and ψ, when the wave enters the ionosphere or emerges from it on retracing its path. The observed polarization of a downcoming wave is determined by these limiting values when the electron density N tends to zero.

According to Mary Taylor[1] (1933, 1934), the limiting polarization is given by $\theta = \pm 45°$ and $\psi = 0$. $\theta = \pm 45°$ means that the wave incident on the ionosphere would split up into two circularly polarized components with opposite senses and if they retrace their path they would possess the same polarization on emergence from the ionosphere as on entry into it. The calculations of Martyn[2] (1935) and of Ghosh[3] (1933) for increasing values of the electron density N in the ionosphere (with certain assigned values for the electron collision frequency ν) following the method given by Bailey[4] (1934) have however shown that as N tends to zero, the values of θ and ψ, in the case of vertical propagation tend to certain limiting values which are not $\pm 45°$ and $0°$ and which depend on the angle between the direction of propagation and the direction of the earth's magnetic field and also on the wavelength and electron collision frequency.

The Bailey's method of conformal representation as applied to the Appleton[5]-Hartree[6] formulæ for the determination of θ and ψ has already been given in detail by Martyn (1935) and Ghosh (1938). We shall give here an outline of this method.

The Appleton-Hartree formulæ for the refractive index μ, absorption coefficient k and polarization R can be written as:

$$M^2 = c^2q^2 = (\mu - i\chi)^2 = 1 + \frac{1}{(\alpha+i\beta) - \frac{\gamma_T^2}{2(1+\alpha+i\beta)} \pm \sqrt{\left[\frac{\gamma_T^4}{4(1+\alpha+i\beta)^2} + \gamma_L^2\right]}} \qquad (1)$$

and

$$R = \frac{h_z}{h_y} = \frac{1}{i\gamma_L}\left[\frac{1}{c^2q^2-1} - \alpha - i\beta\right] \qquad (2)$$

where M = complex refractive index $= cq$

$$\chi = \frac{ck}{p}$$

$$\alpha = -\frac{p^2}{p_0^2 - \nu^2},\ \beta = \frac{p\nu}{p_0^2}$$

$$\gamma_L = \gamma\cos\theta',\quad \gamma_T = \gamma\sin\theta'$$

in which

$$p_0^2 = \frac{4\pi Ne^2}{m},\quad \gamma = \frac{pp_H}{p_0^2},\quad p_H = \frac{He}{mc}$$

and m, e = mass and charge respectively of an electron

N = electron density

H = intensity of earth's magnetic field

θ' = angle between H and direction of propagation

p = angular frequency of the wave

ν = electron collisional frequency.

Now eliminating $(c^2q^2 - 1)$ from equations (1) and (2) and denoting the value of R with the negative and positive signs as R_0 and R_x corresponding to the ordinary and extraordinary components, we get

$$R_0 + R_x = \frac{i\gamma_T^2}{\gamma_L\left(1+\alpha+i\beta\right)} = \frac{2}{x+iy} \qquad (3)$$

and

$$R_0R_x = 1 \qquad (4)$$

where

$$x = \frac{\sigma\nu}{p_H},\quad y = \frac{\sigma p}{p_H}\left(1 - \frac{p_0^2}{p^2}\right)$$

and

$$\sigma = \frac{2\cos\theta'}{\sin^2\theta'}.$$

The major axis of the polarization ellipse is inclined to the Z-axis at an angle ψ and is given by

$$\tan 2\psi = \frac{-2\rho\cos\phi}{(1-\rho^2)} \qquad (5)$$

and the ratio of the axes which we will call $\tan\theta$ can be written as

$$\tan^2\theta = \frac{(1+\rho^2)\sin 2\phi + 2\rho\cos\phi}{(1+\rho^2)\sin 2\phi - 2\rho\cos\phi} \qquad (6)$$

As it is evident from equations (5) and (6) we require ρ and ϕ for the calculation of ψ and θ. ϕ and ρ are calculated by Bailey's method in the following way:

Values of x and y are calculated by substituting required known data. Two circles of diameters x^{-1} and y^{-1} passing through origin and having their centres on the axis of ξ and η are drawn as shown in Fig. 1. The other

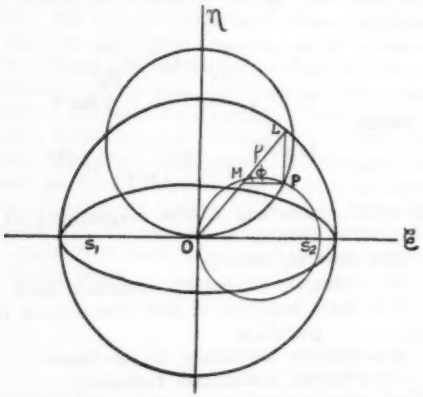

FIG. 1. Illustrating ρ and ϕ in Bailey's method.

point of intersection is also the point of intersection of confocal ellipses and hyperbolæ having their focii on the axis of ξ at $\xi = \pm 1$. From the properties of confocal ellipses and hyperbolæ it can be shown that if P be the point of intersection, then PL drawn parallel to the η-axis cuts the asymptote to the hyperbola on the auxiliary circle of the ellipse at L and PM drawn parallel to the ξ-axis cuts the asymptote at M, then $LM = \rho$ and angle $LMP = \phi$.

Following Bailey's method of conformal representation, we have computed the values of θ and ψ, for $N = 0$ for vertical propagation considering wavelengths much more and much less than the gyromagnetic wavelength for Banaras. Taking the total magnetic intensity H at Banaras on the earth's surface to be 0·446 Gauss the gyromagnetic wavelength λ_H for Banaras comes out to be 240·3 metres. In Fig. 2, the computed values of θ and ψ for wavelengths corresponding to multiples and sub-multiples of the gyromagnetic wavelength are plotted for four different values of the electron collision frequency (i) $\nu = 0$, (ii) $\nu = 10^6 < \nu_e$, (iii) $\nu = \nu_e$, and (iv) $\nu = 10^7 > \nu_e$, where ν_e is the critical collision frequency. The dip-angle at Banaras being 36° 26′ N., ν_e comes out to be 4·49 Mc./s. for H = 0·446 Gauss at Banaras.

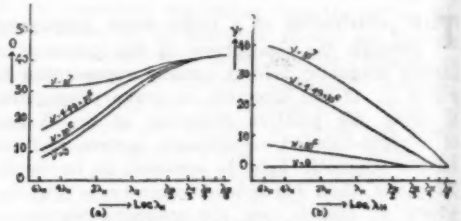

FIG. 2. (*a*) Variation of θ with λ;
(*b*) Variation of ψ with λ.

The variations of θ with λ as represented in Fig. 2 (*a*) show the following features: (i) The value of θ decreases from a limiting value 45° to zero as the wavelength is gradually increased from a very low value to a high one. (ii) There is a wavelength in the neighbourhood of $\lambda = \lambda_H/3$ beyond which the rate of variation of θ with respect to λ is small and for $\lambda < \lambda_H/3$, θ tends to the limiting value of 45° irrespective of the electron collision frequency value. (iii) For a given wavelength, the rate of variation of θ with λ decreases as the electron collision frequency increases. The variation of the tilt-angle ψ as represented in Fig. 2 (*b*) show the following features: (i) $\psi = 0$ for all wavelengths when $\nu = 0$, (ii) For a particular value of the electron collision frequency, ψ tends towards zero as the wavelength is decreased. (iii) When $\nu < \nu_e$, ψ becomes sensibly zero for $\lambda < \lambda_H/3$. (iv) When $\nu > \nu_e$, ψ becomes sensibly zero for $\lambda \ll \lambda_H/3$. (v) For a particular wavelength, ψ increases from zero upwards as the electron collision frequency increases. It can thus be concluded that the limiting values $\theta = \pm 45°$ and $\psi = 0$ as given by Mary Taylor are valid only when $\lambda < \lambda_H/3$.

Our sincere thanks are due to Prof. S. R. Khastgir for his keen interest and suggestions.

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LIPOPROTEIN CHOLESTEROL IN CORONARY DISEASE AND ANAEMIA

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QUALITATIVE and quantitative changes in lipid components of blood, particularly of lipoproteins, in various pathological conditions have attracted considerable attention in recent years (Oliver and Boyd[1]; Gofman *et al.*[2]; Lancet (leading article[3]). According to Anfinsen,[4] lipid complexes, as separated by electrophoresis, are broadly classifiable into chylomicra, α-lipoprotein and β-lipoprotein. Of the various lipid fractions of human blood serum, main interest has centred round cholesterol and β-lipoprotein, which is reported to contain the major portion of serum total cholesterol. Although chylomicra are reported to contain only small quantities of cholesterol (Bragdon *et al.*[5]), it has recently been observed in this laboratory (Pabrai and Sehra[6]) that considerable proportion of this sterol (rather the Liebermann-Burchard positive substances) is present in chylomicra as well as in an additional lipoprotein complex, namely, γ-lipoprotein.

In the present report, an attempt has been made to show that though β-lipoprotein has a special significance in coronary artery disease, changes in its concentration in serum in megaloblastic anæmia are of interest and may lead to a better understanding of the mechanism(s) controlling this lipoprotein.

Material and Methods

The subjects studied in this investigation include 15 healthy services personnel (Medical Category 'A'; age 25-45 years), 12 proved cases of myocardial infarction (all tests done after the crisis was over; age 35-55 years) and 10 cases of megaloblastic anæmia (age 20-40 years). Blood was collected fasting and serum was separated within 1 hr. of blood collection. 0·1 ml. of serum was measured out on Whatman No. 1 paper to form a spot 2-3 cm. in diameter which was allowed to dry under a fan to accelerate drying of the serum at room temperature. This was used for estimating of serum total cholesterol. A similar quantity was subjected to horizontal strip electrophoretic separation. Four strips were put up for each sample, one being stained with Sudan Black B solution for lipoproteins, the second with bromophenol blue solution for proteins and the remaining two being used for extraction of cholesterol in different lipid fractions in duplicate. The unstained strips were also examined under ultraviolet light as a confirmatory measure of the localisation of the different lipid fractions. Two fluorescent spots were normally seen—one markedly fluorescent in the region of α_1-globulin and the other lightly fluorescent almost parallel to the γ-globulin region of the protein-stained strips. Strips of paper were cut to represent different lipoprotein fractions and extraction of cholesterol was completed according to the method of Abell *et al.*,[7] as modified by Anderson and Keys.[8] The colour intensity was measured in the Uvispeck spectrophotometer at 620 mμ, 25 minutes after the addition of Liebermann-Burchard reagent.

Results

The findings are presented in Table I.

Table I

Serum cholesterol content of different lipid components separated by electrophoresis

(1)	No. of cases (2)	Mean cholesterol in mg. % in different fractions					Total cholesterol experimental mg. % (8)
		α-Lipoprotein (3)	β-Lipoprotein (4)	γ-Lipoprotein (5)	Chylomicra (6)	Total of columns 3—6 (7)	
Normals ..	15	33·0 ±13·6	56·2 ±17·0	34·8 ±14·4	37·2 ±22·6	153·0 ±44·0	157·9 ±45·3
Myocardial infarction ..	12	27·7 ± 9·4	122·1 ±28·4	36·4 ± 7·4	34·4 ± 9·4	221·8 ±41·9	215·5 ±49·7
Megaloblastic anæmia ..	10	22·8 ± 8·4	29·6 ±15·2	32·0 ± 7·5	22·8 ±12·5	107·2 ±28·7	108·6 ±27·9

The study indicates that, contrary to the observations of Anderson and Keys (*loc. cit.*), the sum total of cholesterol extractable from α- and β-lipoprotein fractions only is considerably less than that obtained by direct extraction from 0·1 ml. of the serum. It has already been pointed out that this deficiency is made up by cholesterol in γ-lipoprotein and in chylomicra (Pabrai and Sehra, *loc. cit.*).

The table shows that the range of serum total cholesterol in normal Indians obtained by the method of Abell *et al.* (*loc. cit.*) is very much lower than the values obtained by the routine Bloor's method in this laboratory as well as elsewhere (Gopalan and Ramanathan[9]; Padmavati[10]). In our own laboratory, the degree of correlation of the serum cholesterol values obtained by the method of Abell *et al.* to the values obtained by Bloor's extraction method has been found to be 0·8 as compared to 0·836 reported by Anderson and Keys (*loc. cit.*). This difference is most probably due to the smaller number of our cases. In this connection, it may be pointed out that the recalculated values for serum cholesterol by Gopalan and Ramanathan (*loc. cit.*) by application of the above factor ($r = 0·836$) are in accord with our observations.

Our observations of total cholesterol and of β-lipoprotein cholesterol in cases of myocardial infarction are in line with the findings recorded in earlier literature (Gofman *et al.*[11]; Lewis and Page[12]; Swahn[13]; Dangerfield and Smith[14]). In a recent publication, Besterman[15] has observed that a specific pre-β-lipoprotein band was present in 99% of his 200 cases of ischæmic heart disease and that such a band was absent from sera of normal subjects. Although our technique was essentially similar to the one employed by him, the presence of the pre-β band was rather an infrequent feature in the small number of established cases of myocardial infarction studied by us; only 4 of the 12 cases presented here showed a pre-β band. Furthermore, a faint pre-β band existed in 3 of the 10 megaloblastic anæmia cases also. It is thus obvious that the stress on the pre-β band as a specific characteristic of sera of patients suffering from ischæmia heart disease does not appear to be justified.

Megaloblastic anæmia presents an interesting study. While the diminution of total cholesterol in anæmias is an accepted finding, separation of the various fractions of lipoproteins in megaloblastic anæmia shows a probable trend of the mechanisms controlling the levels of β-lipoprotein. This is brought out better in Fig. 1.

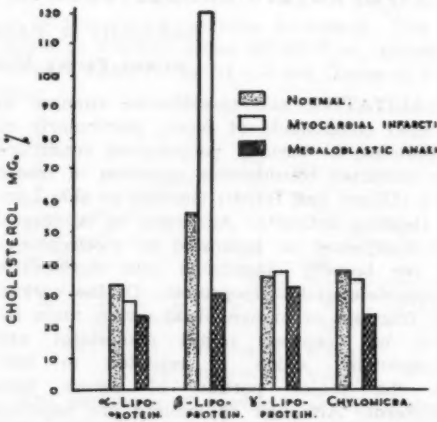

FIG. 1. Distribution of Cholesterol in different Lipid Fractions of Sera.

It is noteworthy that while cholesterol levels in all other fractions are not so markedly affected in myocardial infarction as well as in megaloblastic anæmia, the levels of β-lipoprotein cholesterol are very much elevated in myocardial infarction and markedly depressed in megaloblastic anæmia. The significance of this observation is not understood clearly with the limited data at our disposal. Further work is in progress in this direction.

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VIRUS RESEARCH*

THE appearance of these two splendid volumes in this series has, I feel certain, fulfilled the expectations of virologists. Indeed, they are to be regarded as *vade mecum* of virus pathologists and physiologists, not to mention the many border-line scientists whose approach to the study of viruses has been biochemical or biophysical. Rich as they are in factuals, the highly specialized articles fulfil another purpose: they aim at stimulating new ideas in the specialist and judging from that angle, that keynote has been boldly underlined and admirably executed.

Volume III contains much original material. The chapter on Biochemistry and Virology presents a comparative account on the form and composition of plant viruses, bacterial viruses and animal viruses and critically summarizes available evidences on the fine structure of viral constituents, especially those relating to RNA and DNA contents of virus particles and the amino acid composition of the various strains of plant viruses so far studied. This is followed logically by a chapter on Chemotherapy of Viruses, a subject dealing with the effects of compounds which delay, or inhibit partially, virus multiplication or disease development. As is evident this subject has grown round recent studies on the composition of viruses and the functional mechanism of protein and nucleic acids in virus multiplication and their structure. Many compounds of the purine and pyrimidine analogues have been tried as antagonists and which could, therefore, be incorporated into nucleic acids rendering them biologically non-functional and the possibility of obtaining substantial inhibition of virus multiplication without disorganizing the functioning of the host nucleic acids. The more recent work on metallic ions and chelating agents and the use of antibiotics in relation to virus inhibition is summarized. Work on tumour viruses in bird and mammal is discussed in another chapter and the highlight and emphasis seems to be on the behaviour of the virus of erythromyeloblastic leukosis which "deviates from the average physical structure of other viruses in its pronounced expression of enzymatic activity and its kinship in antigenic constitution with the host cell in which it originates". It requires no great imagination to realize "the possible influence of the specific enzyme in the immediate utilization of the stores of energy waiting within the cell for the purposes of virus multiplication and diversion of the metabolic and genetic processes of the host cell".

An authoritative chapter on the morphology and development of insect viruses needs special mention. Electron micrographs have revealed that the polyhedral virus particles are contained within the polyhedral crystals and are crystalline aggregates of the viruses themselves. New and basic thinking in the field of plant virus multiplication in insect vectors is presented and it seems that there is ample evidence for the presence of viruses that multiply both in plants and animals requiring both hosts for their maintenance in nature, a complex situation, indeed, but pregnant with possibilities for further research in this field. The penultimate chapter discusses certain basic questions of natural and acquired immunity, mechanism of cross-protection, interference between viruses largely based on recent observations of yellows type of plant viruses and the concluding chapter deals with bacterial transformations, particularly, discussing the nucleoprotein nature of genes and the autonomy assigned to genes and viruses which appears to be relative. It is argued that DNA has a key role to perform in these determinations of specificity of hereditary characters and that there are subsidiary structures in cells that could influence the specificity of the newly formed DNA and that such a situation for RNA containing viruses like plant viruses has not been clearly demonstrated.

Volume IV in this series with nine chapters seems equally versatile in its presentation of material. The opening chapter on "Factors in Virus Evolution" includes a critical appraisal of the impact of virus evolution on taxonomy and nomenclature and discusses the possibility of introducing the Linnæan binomial nomenclature to viruses. This author concludes "we may have to be content for ever to sort viruses into small groups just for our convenience and not to attempt to relate our efforts to phylogeny as plant and animal taxonomists do". Many virus workers may not agree with this view but under existing knowledge there seems no escape from this unhappy position. Bacteriophages as genetic and biochemical systems including problems of protein synthesis and nucleic acid functioning forms the subject-matter of the second chapter. Attachment and

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* *Advances in Virus Research*. Vols. III and IV. Edited by K. M. Smith and M. A. Lauffer. (The Academic Press, New York, India: Asia Publishing House, Bombay-1,) Pp. ix + 338; ix + 339. Price $ 7·00 each.

penetration by viruses as a fundamental question and the physical, chemical, immunological, anatomical and genetic approach to a study of this problem and another chapter on measuring concentration of animal viruses involving methods of calculation from mass, volume and density of virus particles are of absorbing technical interest. A detailed consideration of the anatomy of tobacco mosaic virus getting together a large assemblage of evidences on the particle size, surface features, internal structures, etc., make very interesting reading. Other chapters that follow contain information on effects of non-ionizing radiations on viruses, effects of changing temperature on plant virus diseases, mechanical transmissions of plant viruses. The final chapter is on the nature of serological relationships among influenza viruses. From the practical point of view, the chapter on heat therapy and *in vivo* inactivation of certain plant viruses would be read with considerable interest by plant pathologists in this country as many vegetatively propagated clones can be subjected to this therapy and it is to be hoped that some headway would be made in this simple yet practicable control measure.

The reviewer has had the pleasure of warmly commending the earlier volumes in this series and the present review of Volumes III and IV should convince everyone, more than ever, of the enormous part these publications play in stimulating original thinking in a difficult field of research with ultramicroscopic pathogens. There are, here and there, signs of slackness in proof-reading in these volumes but this is outbalanced by a fine get-up and rich scientific matter. One fondly hopes that in the not distant future India would have an Institute for Microbiology with strong arms of virus research in plant, insect, animal and human viruses as it is obvious we have to make much headway in this field of science.

T. S. SADASIVAN.

USSR ACADEMY OF SCIENCES DISCUSS DATA FROM SPUTNIKS EXPERIMENT WITH A DOG

THE dog "Laika" the first animal to travel into space aboard the second Soviet Sputnik stood satisfactorily not only the launching and the orbiting of the Sputnik but also the orbital flight itself.

This statement was made by Academician Aleksandr Topchiev, Chief Scientific Secretary of the Presidium of the USSR Academy of Sciences. He said that the checking of the possibility of survival of an organism in cosmic flight was a unique experiment which has provided valuable data.

Preliminary results of the study of "Laika's" behaviour show that the acceleration of the Sputnik's flight at its launching and orbiting—which is the most difficult stage from the biological standpoint—had acted on the animal in the direction from its chest to its back. He recalled that the movement of the Sputnik was accelerated and that the rate of acceleration was several times higher than the acceleration of gravity. It has been established that simultaneously with the effect of the acceleration the animal was also affected by the vibration and for a certain period by the sound of the rocket engine.

An analysis of the data has shown that immediately after the start the heart action quickened roughly three-fold as compared with its initial state. Later on, as the effect of the acceleration persisted, and even increased, the frequency of the heart action fell. The electrocardiogram did not reveal any ill-effects. It showed a typical picture of thickened heartbeats, the so-called Sinus Tachycardia.

As the apparent weight of the animal increased, its respiration became more superficial and accelerated. At the height of the effect of the acceleration, the number of respirations was 3 to 4 times higher than initially.

Academician Topchiev declared that the animal had satisfactorily stood the flight of the Sputnik from start to orbiting. During the subsequent flight in orbit the animal was in a state of dynamic imponderability. The number of respirations declined, the frequency of the systole continued to fall systematically and to approach the initial magnitude. In spite of the unusual state of imponderability the motorial activity of the animal was moderate.

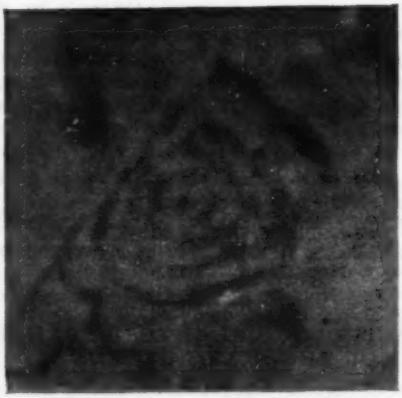
The experiment with "Laika" has demonstrated that imponderability did not in itself cause any substantial or enduring changes in the animal's physiological functions.

LETTERS TO THE EDITOR

GROWTH SPIRALS ON ELECTRO-DEPOSITED SILVER

THE concepts of the edge dislocation[1] and the screw dislocation[2] were originally proposed on purely theoretical grounds to account for the mechanical properties of real metal crystals. A considerable experimental evidence exists now in support of the application of the concept of the screw dislocation to account for the growth of real crystals from low degrees of supersaturation.[3,4] Growth spirals on crystals of hexagonal metals and also of silver (grown from vapour) were observed by Forty[5] and by Frank and Forty.[6]

During the study of the dendritic growth of metal crystals initiated by chemical replacement and also by electrolysis, interesting results were obtained in the case of silver. The crystals of silver were grown by electrolyzing



Showing a Triangular Spiral, × 800.

an aqueous solution of $AgNO_3$ in a specially designed electrolytic cell. The crystals thus grown were essentially cubo-octahedra and it is on the 111 faces that several interesting features were observed. In some cases, these faces were plane to the atomic scale, whereas in certain other cases, growth spirals (triangular, hexagonal and circular) were observed. Fig. 1 is one such typical case. So far no attempts have been made to measure the step heights of the spirals. Some spirals appear to be very flat and can be observed with great difficulty, whereas in a few cases, the spirals could be seen clearly even under an ordinary microscope. These observations suggest that the Burgers vector of the screw dislocation responsible for the growth spiral is not necessarily limited to a unit lattice displacement as is generally assumed. Further work on the interaction of the slip lines (caused by the movement of the dislocations) and the growth steps is in progress. It may finally be mentioned that the spirals could be made more distinct by 'decoration' as described by Frank and Forty.[6]

Dept. of Physics, V. G. BHIDE.
College of Science, W. G. NAFDE.
Nagpur, *January* 6, 1958.

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THE REDUCTION OF THORIUM AT THE DROPPING MERCURY ELECTRODE

THORIUM (IV) is known to give only a catalytic wave at $-1{\cdot}0$ V *vs.* S.C.E. in 0·1 M KCl in the presence of excess nitrate.[1] Since lower valence states, though of low stability have been reported,[2] a more detailed study has been undertaken. In 0·1 M LiC 1, it has been observed that thorium chloride shows two waves, one at $-1{\cdot}6$ V and the other at $-1{\cdot}78$ V *vs.* S.C.E. respectively. The first of these appears as a continuation of the hydrogen wave, the wave height rising both with fall in pH and increase in thorium concentration. The height of the second wave at $-1{\cdot}78$ V is only dependant on thorium concentration.

On a Cambridge photographic recording polarograph with a capillary of characteristics $m^{\frac{2}{3}}t^{\frac{1}{6}} = 1{\cdot}649\ \text{mg.}^{\frac{2}{3}}\ \text{sec.}^{-\frac{1}{2}}$, in 0·1 M LiC1 in the presence of 0·01% gelatin as suppressor, and drop rate 16 per minute at 28·0° C. ± 0·5° C. the following results have been obtained.

When the concentration of thorium is maintained constant at $6{\cdot}48\ \text{M}^{-3}$, in the first wave ($Ea_{\frac{1}{2}} = -1{\cdot}67$ V), the diffusion current lies between 21 and 22 μA in the pH interval 3·42

to 2·00, when allowance is made for the hydrogen wave. In this interval the height of the latter rises from 2·0 to 90·0 μA. Secondly at pH 3·3, the two waves ($Eq_{\frac{1}{2}} = -1{\cdot}67$ V and $Eb_{\frac{1}{2}} = -1{\cdot}78$ V) show a linear rise with concentration of thorium in the range 3·0-12·0 M^{-3}; the average increase in wave height being 3·26 and 1·44 μA per millimole respectively. The extreme values lie between 3·21 and 3·36 μA in the first case and 1·36 and 1·54 μA in the second case.

These two sets of data leave no doubt that a true reduction process is involved in both cases. The actual reduction mechanism is difficult to state at this stage. It may not be a consecutive reduction as $Th^{4+} \rightarrow Th^{2+} \rightarrow Th^{0}$, since the height of the second wave is only a fraction of that of the first wave.

Further work is in progress.

Inorganic Chemistry Labs., Andhra University, Waltair, *November* 25, 1957.

T. P. Sarma.
Bh. S. V. Raghava Rao.

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CHEMICAL EXAMINATION OF *ARISTOLOCHIA BRACTEATA* RETZ.

While we were engaged on a study of the extract from *Aristolochia bracteata* Retz. (Aristolochiaceæ), which was locally regarded as a powerful anthelmintic,[1] Pailer, Belohlov and Simonitsch[2] published two papers in which aristolochic acid, a common constituent of several species of Aristolochiaceæ, was shown to be a rare compound derived from 9-nitro phenanthrene. Coutts, Stenlake and Williams[3] also confirmed this constitution of aristolochic acid.

From the ether-soluble fraction of the alcoholic extract of the fresh roots (1·5 Kg.), aqueous bicarbonate furnished two yellow acidic compounds. The first (yield: 0·1%) crystallised as bright yellow netdles from alcohol: m.p., 275-77° C. (decomp.). (Found: C, 59·9, H, 3·9; N, 3·6; CH_3O, 9·0; $C_{17}H_{11}O_7N$ requires C, 59·8; H, 3·2; N, 4·1; 1-CH_3O, 9·1%.) U.V. absorption data, measured on Hilger Uvispek photoelectric spectrophotometer: $\lambda_{max.}$ 392, log ε, 3·81; $\lambda_{max.}$ 320, log ε, 4·11; $\lambda_{max.}$ 250, log ε, 4·48; $\lambda_{max.}$ 223, log ε, 4·50. In butanol-acetic acid-water (25 : 0·1 : 25), it has $R_f = 0{\cdot}92$. Methyl ester (diazomethane) melted at 278-80° C. (Found: C, 60·8; H, 4·0; OCH_3, 17·9; $C_{18}H_{13}O_7N$ requires C, 60·9; H, 3·7; 2-OCH_3, 17·5%.)

Decarboxylation (copper bronze-quinoline) yielded a nitro hydrocarbon (orange needles, m.p., 204-05° C.) identical with 1-methoxy-9-nitro-5 : 6-methylenedioxy phenanthrene.[2,3] (Found: C, 64·7; H, 4·0; N, 4·5; OCH_3, 10·1; $C_{16}H_{11}O_5N$ requires C, 64·7; H, 3·7; N, 4·7; 1-OCH_3, 10·4%.)

From the above the yellow acidic compound is regarded as identical with aristolochic acid.[2,3]

The second compound crystallised from alcohol as orange yellow needles melting indefinitely between 240-52° C., yield: 26 mg.

The seeds (600 g.) from the capsules of *A. bracteata* Retz. were also examined. Extraction with petroleum ether furnished a greenish brown non-drying oil (Sp. gr. 0·908; Sap. value, 195; Iodine value, 82). Yield: 6%. The defatted seeds, on extraction with acetone furnished a reddish yellow crystalline solid which could be separated into aristolochic acid (55 mg.) and the orange compound (18 mg.) by fractional crystallisation from alcohol.

Dept. of Chemistry, Andhra University, Waltair, *December* 25, 1957.

K. V. Jagannadha Rao.
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PETROLOGICAL INVESTIGATIONS OF THE ROCKS OF MOHAND NEAR DEHRA DUN

The Siwalik rocks exposed along the Mohand Bridge-Kherirau-Bongsot section of Mohand lie between (Long. 77° 55′ 30″ and 77° 55′ 15″ and Lat. 30° 12′ 30″ and 30° 12′). Detailed literature on these rocks is lacking. With a view to study the nature of these rocks and to compare them to the other known Siwalik rocks of Punjab, samples were collected along the dip traverse at stratigraphic intervals of 100′, 200′, 300′ excepting at places where there were lithological variations, over a vertical thickness of 3,650′.

The rocks exposed are mostly sandstones, clays and conglomerates. The sandstones vary from coarse-grained to fine-grained varieties

The clays are mostly brown, maroon-coloured varieties. Conglomerates are composed of pebbles of quartzite, opal, jasper and clay nodules commented by calcite in the matrix. At some places the pebbles in the conglomerates show crude orientation.

Laboratory Investigations

Twenty-five samples of sandstones and 9 samples of clays were treated for petrological studies. The heavy minerals were treated along the lines suggested by Groves.[1] Clays were studied by a simple colouration method given by Vedeneeva and Vikulova[2] and demonstrated by Prof. Tatarsky, Consulting Specialist to the Oil and Natural Gas Commission. Light crop and carbonate minerals were studied by immersion method given by Tatarsky.[3] Mechanical analyses of sandstones were done by the method described by Tatarsky.[4]

The heavy minerals that constitute the assemblage in order of abundance are opaques, garnet, kyanite, hornblende, zoisite, tourmaline, staurolite, rutile, chlorite and zircon of which garnet, hornblende and kyanite form the bulk of the assemblage and the rest are accessory in character. We notice a sympathetic variation of rutile with zircon and colourless garnet with the coloured one. The nature of the assemblage suggests metamorphic and granitic rocks as the probable source rocks for these sediments.

The light crop constitutes the assemblage of quartz, feldspar, rock-fragments and weathered fragments. Quartz occurs in subangular to subrounded grains. The grains are generally colourless but hazy in many cases. Some of the grains show strain effects like undulose extinction. They are full of microscopic inclusions which are irregularly distributed throughout the grains. Under high power objective the inclusions show a rounded or elliptical outline with a faint border. Some of the inclusions appear to be liquid and gas inclusions. There are also mineral inclusions of magnetite, zircon, rutile and biotite in some of the quartz grains. Most of the inclusions are of indeterminate character. Feldspar is present in subordinate amounts. It is remarkably fresh and is mostly orthoclase, untwinned. Some of the feldspars are microline and albite. The rock fragments comprise of mostly quartzite, quartz-feldspar aggregate and quartz-sericite-schist. The nature and study of light crop indicate the source to be metamorphic and granitic rocks, and the source to be near.

Clays were studied by the colouration method and the studies indicate the clays to be mostly of illite composition with various stages of hydrolisation. The uniform composition of clays indicates that the condition of deposition was almost uniform.

Carbonate mineral studies indicate that the nature of carbonate material constituting the cement in sandstones is mostly calcite excepting at the upper part of the section where it is calcite and dolomite. All the sandstones are mostly calcareous and the carbonate content present in them varies from 9% to 37%.

The study of mechanical analyses indicates that the sandstones vary in grain size from coarse-grained to fine-grained falling between coarse-grained sandstone to fine-grained silty sandstones. The sorting is medium but at the bottom of the section the sorting is good. This feature lends support that most of the sediments constituting these rocks were not transported over a long distance.

The entire section comprising a thickness of 3,650′ along Kherirau and Bongsot nalla section could be conveniently divided into three horizons on the basis of the results of the heavy minerals, light crop and clay studies and is shown in Fig. 1.

(1) Samples from 2727-2737 are characterised by absence of green variety of tourmaline and presence of yellow variety of tourmaline.

(2) Samples from 2737-2748 characterised by the presence of hornblende and green tourmaline.

(3) Samples from 2748-2751 characterised by the absence of hornblende.

These boundaries coincide with the boundaries marked by the study of clays. From the study of clays three zones could be conveniently marked along the section.

(1) Samples 2748-2751 marked by illite composition.

(2) Samples 2747-2748 marked by hydrolysed illite.

(3) Samples 2736-2747 marked by illite of varying stages of hydrolysation.

This boundary lies 50′ below the boundary marked by mineral studies.

From the light crop studies, the boundary could be drawn at (1) sample 2735 characterised by quartz-feldspar ratio and hazy quartz border, (2) at sample 2738 characterised by clear quartz border, and (3) at sample 2735 characterised by quartz-sericite-schist and quartz with inclusions of indeterminate character border. All these borders are 100′ above or below the border marked by heavy mineral,

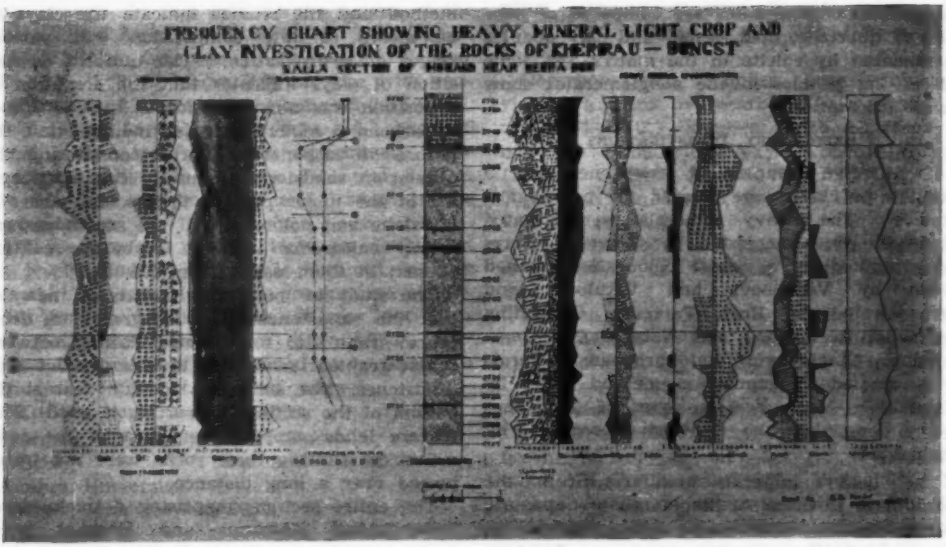

FIG. 1.

and clay border denotes changes in source rocks. The fluctuation and oscillation of the boundary as marked by light mineral studies indicate that the change in conditions of environment was gradual at that period.

From the studies instituted on the rocks of Janaury area (Punjab) the authors notice a very close resemblance and similarity in the heavy mineral assemblage of Mohand and Janaury, though they are separated over a distance of 250 miles. This clearly points to the fact that the source rocks which gave rise to these sediments were the same and the conditions of depositional environment were similar. Further the above studies point that these sediments were not transported over long distance and the source to be near. The deformed nature of kyanite and the strain effects shown by some of the quartz indicate to a highly disturbed source.

It is, therefore, hypothetically suggested that the source rocks which gave rise to these sediments belong to one continuous mountain chain.

The authors express their thanks to Prof. V. B. Tatarsky, Consulting Petrologist to the Oil and Natural Gas Commission, for his valuable guidance and suggestions, and to Dr. A. K. Dey, Director of Geology, Oil and Natural Gas Commission, for the kind permission to publish this paper.[5]

Petrological Labs., Oil and Natural Gas Commission, Dehra Dun, *December* 30, 1957.

S. K. BABU.
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* Original in Russian language.

γ-SUBSTITUTION IN RESORCINOL DIMETHYL ETHER

GRIEHL[1] has described a novel method of preparation of arylacetic acids by the action of potassium permanganate on aromatic substances in boiling acetic anhydride. By application of this procedure to resorcinol dimethyl ether we have obtained an acid, m.p., 152–53° C. (Found: C, 61·0; H, 5·9. Equivalent weight, 194·2. Cal-

culated for $C_{10}H_{12}O_4$: C, 61·2; H, 6·1%. Equivalent weight, 196.) The acid formed an amide, m.p. 157° C. (Found: N, 7·0. Calculated for $C_{10}H_{13}O_3N$: N, 7·2%.) The product of oxidation is therefore 2 : 6-dimethoxyphenylacetic acid[2,3] and represents a novel case of γ-substitution in the resorcinol nucleus.

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Dept. of Chemistry, K. S. NARGUND.
Karnatak University,
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CELLULOSE DECOMPOSITION BY SPECIES OF *NOCARDIA*

QUITE recently Metcalfe and Brown[7] isolated from soil a species of *Nocardia* possessing the ability to decompose cellulose and they gave a valuable determinative description of it and named it as *Nocardia cellulans* apparently assuming that the power of cellulose decomposition had not previously been reported for the genus *Nocardia*. The object of the present communication is to point out that, although detailed descriptions of the *Nocardias* associated with cellulose decomposition had not previously been given, cellulolytic activity had been attributed to the genus before.[3-5] A detailed description of the unnamed *Nocardia* species isolated from marine sources some six years ago is also included in this paper (Table I) with a view to emphasising the cellulolytic power shared by the genus *Nocardia*. No attempts will here be made to describe the five species isolated anaerobically (the organism being capable of growing aerobically) from cellulose enrichments set up with the intestinal tract of the Indian earthworm and briefly reported upon by Khambata and Bhat.[6]

The cellulose enrichments made with the intestinal contents of the earthworm yielded 39 bacteria and 49 actinomyces.[6] Of the 49 latter isolates, 28 belonged to the genus *Nocardia* and the rest proved to be cellulose utilising *Streptomyces*. A comprehensive account of all the isolates had been presented in theses before.[5] Of the 28 *Nocardias*, 23 were identified as *N. corallina* despite certain differences in characters as detailed for the species in the *Bergey's Manual*.[1] The remaining 5, isolated from anaerobic enrichments (but capable of aerobic existence) were only cursorily referred to and remain to be fully reported though they had been described in the theses.[5] However, a brief account of these isolates including the observation on the close association of *Mycobacterium agreste* (synonymous with *N. corallina*) with digestion of cellulose[11] had appeared elsewhere.[6]

Similarly the *Nocardias* and other actinomyces obtained from cellulose enrichments made with materials derived from marine sources had been the subject of another study.[3] Freitas[3] studied in detail three of the several *Nocardias* isolated by her from deteriorating fish-nets and cordage and of these one could be referred to as *N. corallina*. However, all the three were carefully examined with respect to their nitrogen and carbon requirements as well as from the point of view of their halotolerance, and were indeed shows to be halophilic in nature and capable of utilising cellobiose, dextrin, starch, cellulose and agar in addition to palmitate and stearate, the substrates being those commonly employed in the tests for cellulolytic activity.[4] It may be of interest in this connection that the authors had emphasised the role of *Nocardia* (and other *Actinomycetes*) in the decomposition of fish-nets and cordage and considered this organism as "one of the important cellulose decomposing *Actinomycetes*".[4]

Thus far over 50 *Nocardias* (derived from soil, earthworm intestine, coconut oil[12] and marine sources) have been studied in detail in this laboratory and a great majority of them have been referred to as *N. corallina* and *N. rubra* as it is both desirable and convenient to avoid, save under exceptional cases, creation of new species but to refer them to the nearest species listed in the *Bergey's Manual*. Accordingly, a detailed account of the morphological and other peculiarities of the *Nocardia* had appeared elsewhere.[13]

TABLE I

Description of the marine species isolated from cellulose enrichments

Morphology and Gram reaction on nutrient agar: Gram positive filaments with a tendency to branching to short-branched rods; fragment to short rods and coccoidal forms within 2 to 3 days. Not acid-fast.

Growth on nutrient agar: Cheese-like smooth, slightly convex, orange or pink colonies with a filamentous margin; colour agrees with either Capucine orange (Ridgway,[9] Plate III, 13, OY-od) or Grenadine (Plate II, 7, R-ob).

Growth on cellulose agar: As on nutrient agar or as pink cheese-like colonies with a spreading margin.

Nutrient broth: Heavy turbidity with either slimy or flocculent sediment; scum-like growth along sides of tube.

Growth on potato: Heavy, either Ochraceous orange (Plate XV, 15'-y-o-b) or Grenadine (Plate II, 7, R-ob).

Growth on cellulose media: (a) *Omeliansky's solution*[8]: Turbidity; filter-paper coloured orange. (b) *Dubos' solution*[2]: Heavy turbidity and sediment; paper light pink. (c) *Peptone sea-water*[3]: Profuse growth, turning paper orange or deep pink. (d) *China-blue-aurin-cellulose agar*[10]: Growth.

Indole: Not formed.

Hydrogen sulphide: Formed in traces to give a faintly positive reaction.

Nitrate peptone water: Nitrate reduced to nitrite, but not ammonia.

M.R. and V.P. tests: Negative.

Litmus milk: Alkalinity and slight reduction of litmus.

Hydrolysis of starch, gelatin and casein: Negative.

Catalase: Positive.

Sugar media: Acid in glucose and mannite, but not in lactose, sucrose, maltose, dextrin, starch and glycerol.

Paraffin utilisation: paraffin utilised; but not phenol, cresol or benzene.

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St. Xavier's College, J. V. Bhat.*
Bombay, *February* 21, 1958.

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STUDIES ON THE STRUCTURE AND PHYSIOLOGY OF THE FLIGHT MUSCLES OF BIRDS

3. Alkaline Phosphatase Activity in the Pigeon Breast Muscle

It has been shown by George and Jyoti[1] and later on by George and Naik[2] that the *pectoralis major* muscle of the pigeon contains two types of fibres, a broad white variety loaded with glycogen and a narrow red variety which contains comparatively little glycogen but large quantities of fat. George and Scaria[3] have shown that this muscle contains a high concentration of lipase and a histochemical study of the lipase activity revealed that the enzyme is confined to the narrow fibres.[4] A similar observation was made in the *pectoralis major* muscle of the bat.[5] Here we report the result of a histochemical study undertaken to demonstrate the localization of alkaline phosphatase in the *pectoralis major* muscle of the pigeon.

The alkaline phosphatase activity was studied on transverse sections of the frozen tissue cut according to the method of George and Scaria.[4] The sections were transferred to clean slides and allowed to dry at room temperature (about 1 hour). They were then fixed in 10% cold (4° C.) formalin for 2 hours,[6] washed in running water for 30 minutes and used for the study after rinsing in distilled-water. The method employed was the revised method of Gomori using sodium glycerophosphate as substrate.[6] The sections were incubated in the substrate medium at 40° C. for 24 hours, treated with cobalt nitrate and ammonium sulphide and mounted in glycerine jelly without counterstaining. Two controls were tried; in one the incubation of the sections in the substrate medium was omitted and in the other the sections were incubated after keeping them in boiling water for 10 minutes.

From previous experience it was found that the pigeon kidney showed very high alkaline phosphatase activity after half-an-hour of incubation, but in the case of the muscle, satisfactory results could be obtained only on prolonged incubation (24 hours). Fig. 1 presents the photomicrograph of a transverse section of the *pectoralis major* muscle of the pigeon showing localization of the enzyme activity. It is clearly seen that the nuclei are deeply stained indicating high phosphatase activity. Of the two types of fibres, the cytoplasm of the narrow fibre shows a higher activity of the enzyme. In the broad fibre on the other hand, the cell border is stained and that too faintly, suggest-

ing that the enzyme is located mainly if not solely in about the sarcolemma. It would appear that most of the transphosphorylation reactions take place in the narrow fibres and the presence of the enzyme at the border of the glycogen-loaded broad fibre is to aid in the transport

FIG. 1. Microphotograph of a transverse section of the *pectoralis major* muscle of pigeon showing localization of alkaline phosphatase activity. (B.F., Broad Fibre; N.F., Narrow Fibre.)

of glycogen from the broad fibres to the narrow fibres. It should be of interest to note here that the enzymes of the Krebs' cycle are confined only to the narrow fibres.[7] A similar condition may be expected in the case of the *pectoralis major* muscle of the bat and other animals in which there are two such distinct types of fibres. This study is now in progress in our laboratories.

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THE SUBCOMMISSURAL ORGAN IN THE GARDEN LIZARD *CALOTES VERSICOLOR*

THE subcommissural organ as a possible secretory centre has been investigated in certain rodents by Wislocki and Leduc.[1,2] and in certain carnivores by Bargmann and Schiebler.[3] These workers concluded that the subcommissural organ is a site of secretory activity and that the products of secretion are released into the third ventricle directly, or indirectly through the agency of the Reissner's fibre. As a result of studies involving electrocoagulative ablation and injection of extracts of the subcommissural organ in the rat, Gilbert[4] concluded that the subcommissural organ has an important endocrine function in water metabolism.

The following is a preliminary report of studies of the morphology and function of the subcommissural organ in the garden lizard.

Brains of garden lizards were fixed in Bouin's fluid, embedded in paraffin, sectioned at 6-7 micra thickness and stained by Gomori's chrome alum-hæmatoxylin phloxin method and Foot's modification of Masson's trichrome.

The subcommissural organ is situated in the roof of the third ventricle in very close ventral relationship to the commissura pallii posterior. It consists of modified ependymal cells lining the roof of the third ventricle. From its caudal end fibrils arise and unite to form a delicate strand known as the Reissner's fibre, which passes into the lumen of the aqueduct (Fig. 1). The cells of the subcommissural organ

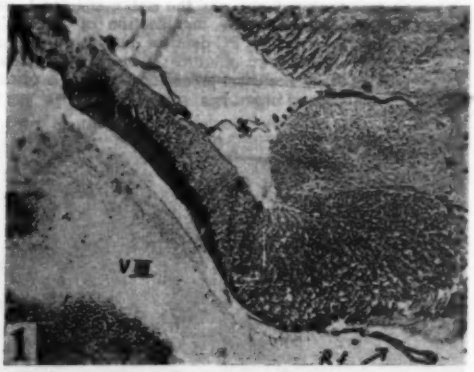

FIG. 1. Photomicrograph of a sagittal section through the subcommissural organ stained by Gomori's method, × 50. (V III denotes the third ventricle, and Rf denotes the Reissner's fibre.)

are of tall ciliated columnar type, with indefinite cell boundaries. The nuclei are situated at various levels close to the basal aspects of the cells, giving the whole epithelium a pseudostratified appearance. The nuclei are of moderate size, vesicular, and show distinct nucleoli and chromatin network. Aggregations of blue-black granules are abundant around the nuclei and the basal parts of the cells. The granules

become discrete and powdery towards the ciliated ends. The cilia are not numerous and are covered by a precipitate, and often show distinct granules embedded in them. From the basal parts of the cells, processes arise, group themselves into thin bundles, and traverse the posterior commissure at the periphery of which the fibres again separate out in a fan-like manner to end in close relationship to the subpial blood vessels (Figs. 2 and 3). These processes

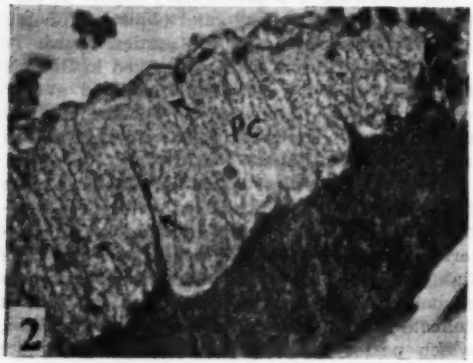

FIG. 2. Photomicrograph of a sagittal section through the posterior commissure and the subcommissura[1] organ, stained by Foot's modification of Masson's trichrome, × 225. (PC denotes the posterior commissure; the arrows point to the secretory material passing along the basal processes of the cells of the subcommissural organ.)

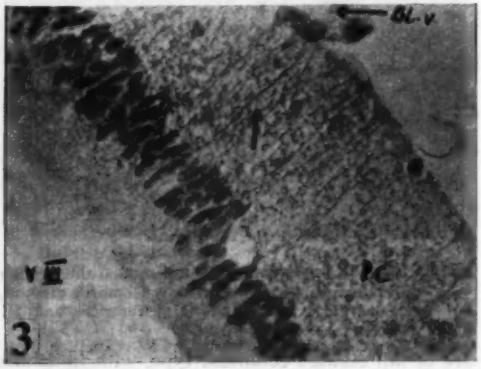

FIG. 3. Photomicrograph of a sagittal section through the posterior commissure and the subcommissural organ stained by Foot's modification of Masson's trichrome, × 225. Note the fan-like ending of the basal processes in relation to the peripheral blood vessel (*Bl. v.*).

are similar to those found in the cuboidal cells of the general ependyma, with the difference that the former carry Gomori-positive material along them. This material can be traced to greater or lesser extents along the processes and in some cases accumulations of the material are seen in the distal ends of the processes in the form of small droplets. In the posterior commissure the nuclei of glial cells took up the chrome-hæmatoxylin stain. But these cells contained no Gomori-positive granules in their cytoplasm.

Thus, while in general features the reptilian subcommissural organ resembles that of the mammal, two important differences exist between the two. Firstly, there is a paucity of the reactive glial cells in the posterior commissure of the reptile. Secondly, the basal processes carrying Gomori-positive material towards the peripheral blood vessels are peculiar to the reptilian subcommissural organ and have not been described in any mammal. Thus the pattern of distribution of the Gomori-positive material in the cells and their processes of the subcommissural organ of *Calotes versicolor* seems to indicate that here, as in the supra-optico-hypophyseal system of this animal,[5] there is a double route available for the discharge of the products of secretion.

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NUCLEAR DIFFERENTIATION IN BINUCLEATE POLLEN MOTHER CELLS

THE writer[1] has described evidence which leads to the conclusion that the capacities for nucleolar and DNA synthesis in a chromosome may be correlated. The evidence was based mainly on the observation that in *Lolium* the DNA-conditioned development of one or more of the chromosomes in a nucleus may be retarded experimentally and when this is done, the affected chromosomes also fail to take part in the synthesis of nucleolar material. The present observations, also on *Lolium*, are of interest in relation to the above conclusion for these too can be interpreted as indicating a close relationship between nucleolar formation and prophase development of the chromosomes.

Normally in perennial rye grass, the pmc are uninucleate and the 14 chromosomes show a completely regular meiotic behaviour. A plant which had been subjected to temperature treatment of $34 \pm 1°$ C. in a thermostatically controlled heat chamber for a period of 72 hours immediately before fixation showed a high percentage of pmc (20%) which were binucleate. These cells in addition to having a normal nucleus have another which is far from normal. Its chromosomes at early prophase reveal a lack of any organised structure and show little or no improvement in their stainability or spiralisation with the advancing of the nuclear cycle. These obviously retarded chromosomes are always found to be localised in a peripheral position in the cell (Figs. 1 and 2). As the chromosomes in this nucleus do not emerge from their near interphase condition, it is not possible to determine their number but the nuclear volume indicates that none may be missing. The second nucleus occupying a central position undergoes regular prophase development; all its 14 chromosomes condensing to the usual metaphase condition, although they fail to pair and appear as univalents (Fig. 2). There is no anaphase separation and the chromosomes in the central nucleus form one or more restitution nuclei. Those in the peripheral degenerate completely.

Apart from the above dissimilarities, the two nuclei also show another conspicuous difference. This is indicated by the invariable presence in the central nucleus of a well developed nucleolus, while no such body is formed at all in the peripheral. The pmc for all the above cytological observations were stained in aceto-carmine after fixation and storage in Carnoy to which a few drops of ferric chloride had been added.

Binucleate pmc with the two nuclei non-synchronised in their development have been described earlier among others by Holden and Mota,[2] who observed them in an *Avena* hybrid. These authors, from a critical consideration of their own results, particularly the constant relationship between the position and behaviour of the two nuclei and on the basis of evidence presented by La Cour[3] in relation to nuclear differentiation in pollen grains, came to the conclusion that a cytoplasmic gradient in respect of the nuclear-forming substances, accounts for the non-synchronised progress of chromosomes in the binucleate cells. The observations on the treated *Lolium* plant appear in all essential respects to be similar to those on the *Avena* hybrid; furthermore the two non-synchronised nuclei also simulate very closely the degenerating vegetative nucleus and the functional generative nucleus in pollen grains both as regards their origin and subsequent behaviour. As pointed out by Darlington and Mather,[1] in the pollen grains of angiosperms one of the two daughter-nuclei is pressed by the first mitotic spindle against the wall, while the other is left in the middle of the cell. Some of

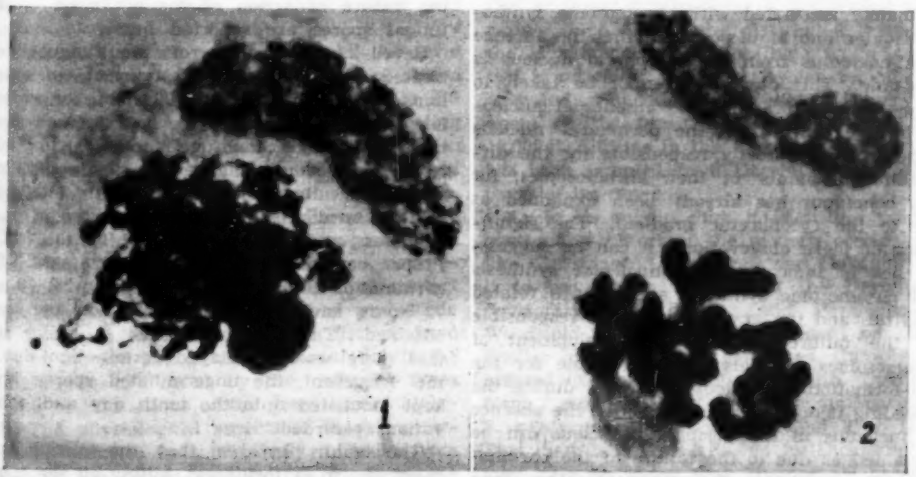

FIG. 1. PMC showing binucleate condition at early prophase. The central nucleus with a well-formed nucleolus is much more conspicuous than the peripheral which shows poor stainability and lack of nucleolar material, × 1,925. FIG. 2. Central nucleus at diakinesis with 14 fully condensed univalents. The peripheral nucleus failing to show any improvement over its early prophase condition, × 1,925.

the binucleate pmc in perennial rye grass show the peripheral nucleus so tightly pressed against the cell-wall that the chromatin material is found to take a semi-circular form (Fig. 1). It is obvious that the peripheral nucleus owes its position and distorted form to the asymmetrically placed pre-meiotic mitotic spindle, one of whose poles, too close to the cell-wall, must have been responsible for pressing the chromosomes during anaphase separation.

In view of the above considerations the conclusion reached by Holden and Mota, that cytoplasmic gradient is responsible for the non-synchronised development of the two nuclei in the *Avena* hybrid, can be accepted for the binucleate condition in *Lolium* also. A second suggestion made by these authors to explain the non-formation of nucleolus in the peripheral nucleus, however, requires further consideration.

In the absence of any evidence indicating that the peripheral nucleus lacks an organiser, these authors have suggested that it is possible that the forces operating to maintain the gradient with its focus at the cell centre have also been responsible for the transference of nucleolar material from this nucleus at the preceding telophase. While the existence of a cytoplasmic gradient in the cell is not difficult to visualise particularly in view of the formation of the asymmetrical spindle, it is not very clear how the postulated transference of the nucleolar material may take place. Referring to the fact that the nucleolar material is believed to be intimately associated with chromosome synthesis, Holden and Mota point out that the absence of a nucleolus from the peripheral nucleus is revealing. This obviously cannot be taken to imply that the presence and absence of nucleolus in the central and the peripheral nucleus respectively is directly responsible for the differential behaviour of their chromosomes, for this behaviour has already been explained as due to the cytoplasmic gradient. The significance of these observations, it can be suggested, lies in indicating that nucleolar synthesis and chromosome synthesis are perhaps related activities and the gradient which is responsible for the failure of prophase development of chromosomes may also be responsible for the non-formation of nucleolar material during the preceding telophase. In other words, the absence of nucleolus in the peripheral nucleus can be explained as due to the failure of the chromosomes to synthesise the materials rather than their removal after synthesis.

Both nuclear differentiation and preferential nucleolar formation in the binucleate pollen mother-cells would thus appear to be a function of cytoplasmic gradients.

I am indebted to Prof. P. T. Thomas for valuable advice and criticism. My thanks are also due to Prof. E. T. Jones and Mr. A. R. Beddows for their helpful interest; and to the Royal Commissioners, 1851 Exhibition, for the award of one of their scholarships.

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THE FUNGISTATIC AND FUNGICIDAL ACTION OF MYCOSTATIN ON *DEIGHTONIELLA TORULOSUM*

THE inhibitory action of mycostatin on *Deightoniella torulosum* (Ashby) Ell., among other fungi pathogenic to banana, has been reported elsewhere by the authors.[1] The antibiotic was found to inhibit the germination of the spores of *D. torulosum* at 10 mcg./ml., whereas at concentrations lower than 2·5 mcg./ml. there was little or no inhibition and at 5·0 mcg./ml. there were malformations of the germ tube. The results of further studies made to investigate into the nature of action of the antibiotic on the fungal spores are reported here.

Seven-day-old spores of the fungus were treated with aqueous mycostatin at concentrations ranging from 10 to 100 p.p.m. for various lengths of time. They were then washed thoroughly by centrifugation (800 to 1,000 r.p.m.) in several changes of sterile distilled-water and allowed to germinate in 1% sugar solution on depression slides, incubated in moist chambers at room temperature (22 to 28° C.). Proper controls were kept in each case. The germination counts were taken after 24, 48 and 72 hours and the final germination per cent. obtained (Table I). In order to make sure that there was no delayed germination due to the treatment, the ungerminated spores were kept incubated upto the tenth day and observations recorded.

The results indicate that the antibiotic is fungicidal to *D. torulosum*, killing all the spores at all the concentrations tested, the time required for the cidal effect being more at lower concentrations than at higher concentrations.

TABLE I

The effect of mycostatin treatment on the viability of the spores of Deightoniella torulosum

Duration of treatment (hours)	% germination at :				
	0 p.p.m.	10 p.p.m.	25 p.p.m.	50 p.p.m.	100 p.p.m.
1 ..	100	94	91	0	0
2 ..	100	86	80	0	0
4 ..	100	80	85	0	0
8 ..	99	68	12	0	0
24 ..	100	19	6	0	0
48 ..	90	0	0	0	0
72 ..	98	0	0	0	0

The effect of mycostatin on the germinating spores of the fungus was also studied. The spores were allowed to germinate in 1% sugar solution. After an interval of 48 hours, when a good number of the spores germinated, aqueous mycostatin, to obtain a final concentration of approximately 5 p.p.m., was added to the medium. Though there was no subsequent growth of the germ tubes, characteristic malformations were observed within 24 to 48 hours. The terminal cells of the germ tubes were malformed into thick-walled, irregular-shaped, brown to dark brown coloured cells, approximately 2 to 3 times broader than the hyphæ. These malformations differ from those obtained from the spores pre-treated with mycostatin, in the respect that they are thick-walled and brown-coloured.

The two types of malformations of the germ tubes were washed in several changes of sterile distilled-water and allowed to germinate in 1% sugar solution as before. Even after incubating for 10 days both the malformations failed to germinate, even though some of the attached bits of the normal germ tubes grew well, developing into mycelial strands in the medium.

These results indicate that mycostatin is fungicidal to *D. torulosum* at various concentrations depending upon the time of contact with the antibiotic. The action of mycostatin on the germ tubes seems to be distinct from that of the pre-treatment of the spores with the antibiotic as indicated by the different types of the malformations of the germ tubes obtained. The physiological aspects of these malformations seem to be significantly different from those of the spores as they fail to germinate under the conditions optimum for the normal spore germination and growth of the fungus. The fungistatic effect of the antibiotic is indicated by the fact that the bits of the normal germ tubes from the treated spores grew into mycelial strands when restored to 1% sugar solution.

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CYTOLOGY OF FERN GENUS *ACROPHORUS*

Acrophorus is an interesting isolated genus chiefly represented in the Old World, typified by *A. stipellatus* (Wall.) Moore.[1-3] The second species to be added was *A. raiteensis* J. W. Moore from Raiatea in 1933.[4] A year later Christensen and Holttum[5] grouped a more finely dissected and palæaceous form of the former in a separate species, *A. blumei* Ching apud Chr. (*A. blumei* Ching[3]) from Mt. Kinabalu. Still later Tagawa[6] in 1939 described a new variety, *A. stipellatus* var. *macrostegius* from Formosa. Out of these *A. stipellatus* is indigenous to the mainland of Asia, being distributed throughout the Himalayas and South China while *A. blumei* is restricted to the Malaysian region. The only Indian species, *A. stipellatus*, is very frequent on the forest floor between 6,000 ft. to 10,000 ft. altitude in the Eastern Himalayas and has been sampled from Darjeeling and Sikkim parts of its range.

As to its relationship, it is still a point of controversy. Most of the modern pteridologists like Christensen,[7] Copeland[3] and Holttum[8] hold it to be a close relative of the Dryopteroid ferns especially *Dicalpe* and *Peranema*—the Woodsioid ferns of Bower.[9] Based on almost similar morphological evidences Ching[10] expressed its natural affinities with Davallioid ferns, more with *Leucostegia*, in particular *L. perdurans* Christ and classified it so later.[2] This view has been followed by Dickason.[11] It may here be added that Thompson[12] based on her studies on the sorus and prothallium development in *Acrophorus stipellatus* from Java

supports its Dryopteroid affinity. While a more thorough and complete comparative picture of the various characters of taxonomical importance for the proper understanding of its systematic position awaits publication, this note aims only to place on record the chromosome number for the genus which remains unreported so far.

Acetocarmine squashes of the young sporangia of *Acrophorus stipellatus* (Wall.) Moore, collected at Karponang (10,000 ft.) in Sikkim; Birch Hill forests (7,000 ft.), Senchal forest (8,000 ft.), Lebong forest (5,500 ft.), near Tonglu and Tonglu to Gairabas (8,000 to 10,000 ft.) in Darjeeling District and fixed in 1 : 3 acetic alcohol, have been obtained. The species exhibits a great variation in its size ranging from 1-5 ft. However, considering the degree of variation, cytologically the species is conspicuous by its extreme uniformity. Perfect regular course of meiosis results in 64 normal and seemingly viable spores. At late diakinesis 41 bivalents become clearly recognisable (Fig. 1) which is thus the haploid number for the genus.

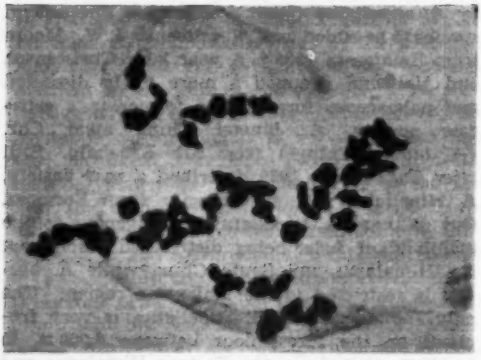

FIG. 1. Late diakinesis in a spore mother-cell of *Acrophorus stipellatus* (Wall.) Moore (Gairabas collection—8,000 ft. alt.) showing $n = 41$, × 1,500.

Leucostegia as delimited in the modern sense,[3] includes only two species while all the rest have been transferred to the closely allied genus *Araiostegia*. Therefore Ching's reference *L. perdurans* would seem very likely an *Araiostegia*. Among the Davallioids (Davalliaceæ of Copeland[3]) *Leucostegia*,[13] *Oleandra*[13] and *Nephrolepis*[13,14] possess 41 as their base number while *Davallia*[14] and *Araiostegia*[13,14] are based on 40. As far as Woodsioid[14–16] ferns are concerned, the number 41 forms the basis of their evolution. The data on the chromosome number of ferns have so far suggested that a given base number usually remains constant in large, related assemblage and "that aneuploidy tends to characterise the relation between genera rather than between species" (Manton[16]). Hence the cytology alone as such seems to be incompetent in resolving the present tangle unless it is supported by other evidences. Such evidences would appear elsewhere.

The writer is deeply indebted to Professor P. N. Mehra for his helpful guidance, criticism and encouragement during the course of investigation.

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NOTE ON *GONIOZUS* SP. (BETHYLIDÆ—HYMENOPTERA) PARASITE OF STEM AND ROOT-BORERS OF SUGARCANE IN BIHAR

SINCE biological control of insects, besides being economic in ultimate analysis, is a permanent means of pest repression, attempts are being made at the Sugarcane Research Institute, Pusa, to collect and study all the parasites commonly associated with the sugarcane-borers in Bihar. The present note incorporates the results of preliminary studies conducted on one of them. This parasite identified as *Goniozus* sp. was reared from parasitised larvæ of the stem-borer, *Chilotræa infuscatellus* Snell., and the root-borer *Emmalocera depressella* Swinh. collected from the standing sugarcane crop at the Research Institute's farm during 1956 and 1957. It is an endo-parasite and available

mostly in the months of August-November. Under natural conditions its parasitisation is more pronounced on stem-borers as compared to root-borers. Its full-grown grubs emerge by puncturing the ventro-lateral portion of the host's body and immediately spin closely knit brown silken cocoons within which they pupate. The pupa within the cocoon is creamy white in colour and the duration of this stage varies from 7-9 days during August under laboratory conditions. The maximum number of adults emerging in the laboratory from a cluster of cocoon was, on an average, eleven. The adult female which is quite agile has dark brown colour and hyaline wings. The well developed dentitions of its mandible and the comparatively large size of the hind pair of legs have been observed to confer upon the parasite additional facility in keeping the host under control while parasitising it. The adult of *Goniozus* sp. has a close resemblance to *Goniozus cuttockensis* Lal., the pupal parasite of stem-borer at Cuttack, Orissa, reared by M. Ahmad during 1937 and described by Lal[1] in 1939. Further studies on *Goniozus* sp. are under progress and the detailed observations will be published separately.

The authors are greatly indebted to Sri. K. L. Khanna, Director, Sugarcane Research and Development, Bihar, Pusa, for the facilities and encouragement in the work. Thanks are also due to the authorities of British Museum, London, for so kindly identifying the parasite.

Sugarcane Res. Inst., Pusa, Bihar, December 20, 1957.

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THE EFFECT OF CERTAIN INSECTICIDES ON THE LARVAE OF *ANOMIS SABULIFERA* GUENTHER

Anomis sabulifera Guenther, commonly known as the jute semi-looper, is one of the major pests of jute. Its larvæ are voracious feeders on leaves and growing apex of both the cultivated species of jute, *viz.*, *Corchorus capsularis* and *C. olitorius*.

Jute being a rainy season crop—control of its pests with insecticides is often met with little success as the insecticidal deposits are often washed off by heavy rains or drifted away by high winds in the field. Therefore, the time required to obtain a quick mortality of the pest is of much practical importance.

Dutt and Ganguli[1] and Ganguli[2] have reported earlier the effect of several insecticides in different dosages on the semi-loopers. This brief note presents the results of laboratory investigations with some insecticides, each tested at a particular dosage level, in order to assess their abilities in bringing about a quick mortality of the semi-loopers as a prelude to their application in a larger scale under field conditions.

The insecticides used in these investigations were Folidol E.605, Endrin 19·5% E.C., Aldrin 40% W.P., Dieldrin 50% W.P. and DDT 50% W.P. The comparative toxicity of all these five insecticides has been determined by the method of direct spray (Ganguli, op. cit.). The larvæ were bred in the laboratory and only 3rd and 4th instars of them were used as test material. Ten larvæ selected at random and kept in each petridish of 12·5 cm. diameter, forming one replicate were sprayed by means of an atmoizer. Quadruplicates were run for each of the five insecticides. Mortality counts at hourly intervals are represented in Fig. 1.

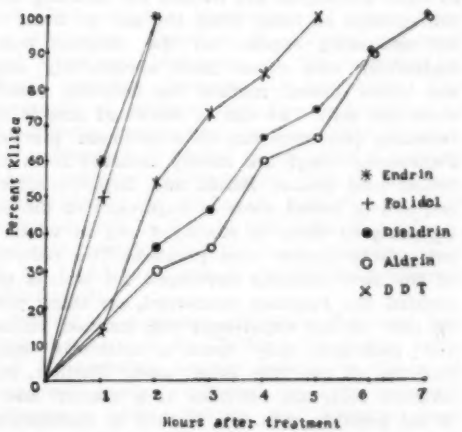

FIG. 1. Effects of Endrin, Folidol, Dieldrin, Aldrin and DDT on the larvæ of *Anomis sabulifera* Guenther.

From Fig. 1 it will be seen that *Endrin at a dosage level of 0·12% can effect 60% mortality within 1 hour of application and *Folidol at 0·01% gave 50% mortality. While the corresponding figures for *DDT at 0·75% being 13%, *Aldrin and *Dieldrin both at 0·4% failed to produce any death within 1 hour of application. For effecting 100% mortality Endrin and Folidol took 2 hours, DDT 5 hours and Aldrin and Dieldrin 8 hours. Thus the performances of Endrin and Folidol are bet-

ter than the rest of the insecticides tested under the laboratory conditions.

Thanks are due to Dr. B. C. Kundu, Director, Jute Agricultural Research Institute, Barrackpore, for his keen interest in the work, and to Dr. N. Dutt, Assistant Entomologist, for his suggestions.

Jute Agric. Res. Inst., §R. N. GANGULI.
Barrackpore, *January* 10, 1958.

* In terms of actual insecticidal ingredient.

§ Present Address: Assistant Entomologist, Tocklai Experimental Station, Cinnamara P.O., Assam.

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A TECHNIQUE FOR ISLOLATING PATHOGENIC CULTURES OF *PYTHIUM* FROM THE SOIL

SPECIAL techniques are needed for isolating certain groups of fungi from the soil as these do not ordinarily appear on the dilution plate. Sadasivan[1] and others have successfully used the 'straw burial' method for isolating fusaria from the soil. The use of sterilized insects for isolating phycomycetes is a common practice. Pathogenic fungi are mostly isolated from infected host tissue. Rands and Dopp[2] transferred bits of rotted roots of sugarcane or the soil adhering to them to sterilized soil in which a susceptible variety was planted. The root-tips of the new seedling developed rot lesions and yielded the *Pythium* concerned, on being plated out. In my experience this method yielded the pathogen only from a relatively small number of the 'live baits' used. Further, rot-affected roots are essential as a 'starter' and it is not possible with this method to demonstrate the presence of the root rot organism in the soil in the absence of the actual occurrence of the disease.

A technique tried in this Institute in connection with a study of sugarcane root rot, has frequently yielded isolates of *Pythium* and other phycomycetes even in the absence of a previous case of root rot. Soil is filled into a pot and one or more single-eyed sugarcane cuttings are planted. The soil is watered to saturation. The pot is now covered by inverting over it another pot of a slightly smaller size so that, light is completely excluded. The moisture content of the soil is maintained at near saturation level by means of capillary irrigation. Three to four weaks later the cover is removed, the plants are taken out and the roots are washed free from soil. Many of the roots show discrete red lesions and the pathogen is isolated by plating bits of the roots after repeated washing in sterile water. Often the ætiolated shoot is invaded and the surface is covered by cottony growth of fungal mycelium. Direct transfers from this frequently yield pure cultures of *Pythium*. This is probably due to the high humidity of the enclosed chamber and the exclusion of aerial contaminants.

When a highly susceptible variety like Co. 467 was used, isolates of species of *Pythium* were obtained more frequently (65%) than when a resistant variety like Co. 617 was used (15%).

Carpenter[3] found that heavy applications of nitrogen predisposed sugarcane plants to *Pythium* root rot attack. The unbalanced carbon-nitrogen ratio in the tissues of the ætiolated plants produced with the technique under report is possibly responsible for the ease with which the pathogen attacks the tissues. In one experiment ammonium sulphate solution was added to the soil before covering the pots. The ammonium sulphate-treated plants yielded species of *Pythium* in 18 out of 20 cases while in the absence of the fertilizer only 11 out of 20 gave *Pythium*.

The majority of isolates obtained by this method from sugarcane soils belonged to *Pythium graminicolum* Subram. and *P. debaryanum* Hesse. A few isolates of *P. aphanidermatum* (Eds.) Fitz. and other species and occasional isolates of an undetermined phycomycete were also obtained. In infection tests all the isolates proved to be pathogenic to sugarcane (variety Co. 419) in varying degrees.

Employing this technique the presence of pathogenic species of *Pythium* was demonstrated in a number of soils both in the alkaline as well as the acid range. The possibility may be envisaged of isolating pythiaceous fungi pathogenic to various species of plants by using the appropriate host.

I am grateful to Mr. N. L. Dutt, Director of this Institute, for encouragement.

Sugarcane Breeding Inst., K. V. SRINIVASAN.
December 20, 1957.

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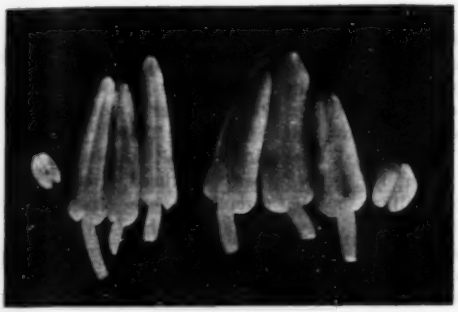
MALE STERILITY IN *CROTALARIA STRIATA*

In a collection of species of *Crotalaria* maintained at the Agricultural College, Hebbal, Bangalore, a single plant was noticed in a line of *Crotalaria striata*, D.C. with poorly developed anthers, in 1956. The flowers opened normally, the anthers were small, green, empty and did not dehisce; while in the normal plants the anthers were big, yellow and plumpy (Fig. 1) with abundant yellow pollen. On



TEXT-FIG. 1. Anthers of a normal flower (right) and those of the male sterile flower (left).

squashing the poorly developed anthers in a drop of acetocarmine all the microspores were found to be shrivelled up and devoid of any contents. Some of the inflorescences were covered with bags and no pod and seed formation was found while the inflorescences under open and cross-pollinations bore pods and seeds. It could therefore be inferred that the plant was male sterile. The many known cases of heritable male sterility are controlled by either genetic or cytoplasmic factors or by gene-cytoplasm interaction. In our material the plants raised from seeds collected on the male sterile plant, under open pollinated condition were also male sterile. This may be due to either the male sterile gene being dominant over the normal or male sterility being under cytoplasmic control. So far, male sterile genes under the control of nuclear gene have been reported in the recessive state only (Beadle, 1932). If alternatively, the gene is of the cytoplasmic type, it should be possible to find out whether there are any fertility restorer genes in the normal compliment. With this in view, male sterile plants have been crossed with a number of normal ones and the results are awaited. Since the hybrids between male sterile × normal exhibited luxurious vegetative growth, there may be possibility of using the male sterile plant for exploiting hybrid vigour in this green manure crop.

We wish to acknowledge with thanks the facilities and the encouragement given by Sri. B. Venkoba Rao, Principal, Agricultural College. We are also grateful to Sri. S. S. Rajan, Assistant Cytogeneticist, Indian Agricultural Research Institute, New Delhi, for his help in the preparation of the manuscript.

Agricultural College, Hebbal, Bangalore-6, *January* 16, 1958.

C. KEMPANNA.
K. S. KRISHNA SASTRY.

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OBSERVATIONS ON THE SEAWARD MIGRATION OF *MUGIL CEPHALUS* LINNAEUS FROM THE CHILKA LAKE FOR BREEDING*

SAROJINI,[1] in a review on the biology of Indian grey mullets, has invited attention to the conflicting views as to the habitat where the estuarine species of the Indian mullets breed and Thomson[2] has mentioned of observations by Australian, Egyptian, S. African, Japanese and American biologists on the breeding of *Mugil cephalus* Linnaeus in particular. The consensus of opinion favours sea-breeding of *M. cephalus* recognising the possibility of occasional breeding in barred estuaries or in lagoons where salinity approximates that of the sea. The observations of Nair,[3] Belloc[4] and Dill[5] may thus fall in line if this view is held. It, however, remains that the coast breeding habit of *M. cephalus* is yet to be finally confirmed (Kesteven[6]).

Mullets, as a group, constitute the most important fishery of the Chilka Lake among fishes and *M. cephalus*, among mullets, is the most dominant species followed by *Liza troschelli* (Bleeker). Little definite has hitherto been known about the breeding migration of any species of Chilka mullets of which ten are known to occur in the lake. A precise knowledge of the pattern of migration of Chilka mullets has a direct bearing on the conservation programme of the lake's mullet fishery.

Observations made in the outer channel part of the lake, in the lake mouth proper and in the sea-board adjoining the lake mouth, in the months October to December 1957, throw

* Published with the permission of the Chief Research Officer, Central Inland Fisheries Research Station, Calcutta.

light on the migration of *M. cephalus* from Chilka Lake into the sea for breeding. The migrating *M. cephalus*, the male among which averaged $373{\cdot}5 \pm 2{\cdot}15$ mm. and the female $534{\cdot}24 \pm 4{\cdot}34$ mm. in total length in October 1957, are caught by cast nets in the outer channel generally during high-tide, and schools of migrating fish, with their heads slightly projecting out of water, can be clearly seen particularly while traversing the narrow lake mouth (about 200 yards wide in high-tide). Cent. per cent. of the migrating fish are in Stages V to VI of maturity following Kesteven's[7] criteria. On reaching the sea, these mullets appear to keep close to the shore at both the north-eastern and south-western parts of the coast. Local fishermen capture them in fair numbers from the breakers with stick nets (Khari Jal) operating the gear in inter-tidal zone from the beach itself. During the autumn and winter months ripe *M. cephalus* (males averaging $396{\cdot}1 \pm 4{\cdot}83$ mm. and females $538{\cdot}26 \pm 2{\cdot}67$ mm. in total length in October 1957) captured from the sea in the vicinity of the lake mouth, forms a lucrative fishery. Schools of mullets are often very clearly seen in the sea through the wave crests under favourable conditions of light. These fishery observations corroborated by certain others such as the availability of mullet fry in the sea, even far away from the lake mouth, their migration from the sea into the lake, appearance of spent fish and other relevant observations are being made and data analysed. There is also evidence available to demonstrate similar migratory habit of certain other mullets of the Chilka Lake like *Liza troschelli* (Bleeker), *L. borneensis* (Bleeker), *L. ceruleomaculatus* (Lacepede) and certain other smaller mullets collectively called "Menjia" in local terminology. The details of these observations will be published elsewhere.

Chilka Investigation Unit, V. G. JHINGRAN.
Balugan (Orissa),
January 29, 1958.

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NOTE ON *HYMENIA FASCIALIS* C. A PEST OF SUGARBEET

SUGARBEET (*Beta vulgaris*) like any other crop is attacked by various insects at each and every stage of its growth from germination till harvest. The species recorded at Pusa (Bihar) include: *Plusia nigrisigna* Walker,* *Chalciope hyppasia* Cram.,* *Diacrisia todara* Moore,* *Marasmia trapizalis* G., *Margaronia indica* S., *Schœnobius incertullus* W., *Spodoptera mauritia* B., *Plusia orichalcia* and *Hymenia fascialis* C.

The biology of some of these pests as also preliminary trials to compare the efficacy of various insecticides against these pests were conducted in the laboratory at Sugarcane Research Institute, Pusa (Bihar), with a view to controlling the same. These include: *H. fascialis*, *S. mauritia* and *P. orichalcia*.

Slender, light green coloured, leaf-eating caterpillars of *H. fascialis* were observed in the field as early as March, when on an average 9·6% leaves of sugarbeet were found damaged by this pest. The activity of the larvæ kept on increasing gradually till July when the average infestation was as high as 47·8% and thence onwards the activity started decreasing. The larvæ collected from field, pupated, emerged and laid eggs by third week of March and thereafter the duration of each stage under laboratory conditions was as in Table I.

There was overlapping of broods, and the ratio of males to females in all the generations was on an average 2 : 1.

The efficacy of 5% BHC, 5% DDT, 5% Aldrin and 2·5% Dieldrin dusts was compared in controlling this pest in the laboratory. Sugarbeet leaves dusted uniformly, two leaves with each of the insecticide, were kept in the glass jars. In one of the glass jar, two untreated leaves (control) were also kept. In each of these glass jar, 20 full-grown larvæ were liberated and observations regarding their mortality and pupation were recorded daily. The experiment was replicated five times. The data collected has been summarised in Table II.

The above results show that Dieldrin and Aldrin are superior to BHC and as good as DDT. Within 24 hours 80%, 70% and 70%

* Sincere thanks are due to Dr. W. H. T. Tams, of British Museum (Natural History), London, for very kindly identifying the specimen. The author is greatly indebted to Mr. K. L. Khanna, Director, Sugarcane Research & Development, Bihar, for very kindly suggesting the problem and providing the necessary facilities.

TABLE I

Month	Incubation period (days)	Larval period (days)	Pupal period (days)	Longevity (days)	Average temperature in °F.	Average difference of Max. & Min. temp.	Relative humidity	
							Morning	Evening
April ..	2	11·38	8·00	4·17	85·52	30·65	60·35	25·88
May ..	2	10·50	7·50	2·33	87·51	21·87	79·16	40·15
June ..	2	9·00	5·50	2·00	85·19	9·82	86·84	72·11
July ..	2	9·40	5·78	4·67	83·69	7·38	92·58	86·26

TABLE II

Treatments	1st day		2nd day		3rd day		4th day		5th day		6th day		7th day	
	Mortality %	Pupated %	Mortality %	Pupated %	Mortality %	Pupated %	Mortality %	Pupated %	Mortality %	Pupated %	Mortality %	Pupated %	Mortality %	Pupated %
5% BHC ..	30	nil	50	nil	10	nil	10	nil	..	..	..	..	..	..
5% DDT ..	70	nil	10	nil	20	nil	..	..	..	..	..	..	..	..
5% Aldrin ..	70	nil	30	nil	..	..	..	..	..	..	..	..	..	..
2·5% Dieldrin ..	80	nil	20	nil	..	..	..	..	..	..	..	..	..	..
Control ..	nil	nil	nil	nil	10	10	nil	10	20	nil	nil	20	10	nil

mortality was obtained with Dieldrin, Aldrin and DDT respectively as against 30% in case of BHC. Further trials are in progress and details of the investigations will be published separately.

Sugarcane Entomologist, DHAMO K. BUTANI.
Sugarcane Res. Inst.,
Pusa (Bihar), *February* 25, 1958.

INHERITANCE OF THE *TINY-LEAVED* AND *ALTERNIFOLIA* FORMS IN *CICER ARIETINUM* L.

THE *Alternifolia* form was described by the author in 1952, mentioning it to be recessive to the normal bi-pinnate leaf and segregating with it in a monogenic manner. This type was subsequently hybridized with the *Tiny-leaved* mutant (Ekbote, 1937), which was shown to have behaved as a recessive to the *Normal-leaved* one and determined by a pair of genes designated as tlv tlv (Ekbote, 1942).

As a result of crosses made among several leaf mutations in *Cicer*, Singh and Bhagchandani (1953) symbolized the normal bi-pinnate compound leaf as Slv Slv Tlv Tlv Nlv Nlv and the Tiny-leaf as Slv Slv tlv tlv Nlv Nlv. From a study of a cross between the *Tiny-leaved* and the *Gigas* forms, Chaudhari and Argikar (1957) symbolised the *gigas* form as Slv Slv Tlv Tlv Nlv Nlv glv glv and the tiny-leaved mutant as Slv Slv tlv tlv Nlv Nlv Glv Glv.

On finding that the interaction of the genes involved in the *Tiny-leaved* mutant and the *Alternifolia* plant also produce the *Normal-leaved* condition, it is proposed to further

F_2 Phenotype	Genotype	No. of F_3 progenies	F_3 frequencies	Ratio	X^2	P value
Normal-leaved ..	Tlv Tlv Alv Alv	5	106 *normal-leaved*	True breeding	..	..
	Tlv Tlv Alv Alv	6	190 *normal-leaved* 66 *tiny-leaved*	3 : 1	0·08	0·20—0·50
	Tlv Tlv Alv alv	35	968 *normal-leaved* 399 *alternifolia* 459 *tiny-leaved*	9 : 3 : 4	12·92	0·001–0·01
	Tlv Tlv Alv alv	12	411 *normal leaved* 158 *alternifolia*	3 : 1	2·32	0·10—0·20
Alternifolia ..	Tlv Tlv alv alv	17	809 *alternifolia*	True breeding	..	..
	Tlv Tlv alv alv	18	641 *alternifolia* 244 *tiny-leaved*	3 : 1	1·41	0·20—0·50
Tiny-leaved ..	tlv tlv Alv Alv tlv tlv Alv alv tlv tlv alv alv	17	783 *tiny-leaved*	True breeding	..	..

designate the *Alternifolia* form, which was earlier designated as al al (Bhat and Argikar, 1952) and reported to be recessive to the normal, as Slv Slv Tlv Tlv Nlv Nlv Glv Glv alv alv and the *Tiny-leaved* one as Slv Slv tlv tlv Nlv Nlv Glv Glv Alv Alv, the mode of their inheritance being as follows:

Cross : $\frac{\textit{Tiny-leaved}\text{ mutant}}{\text{tlv tlv Alv Alv}} \times \frac{\textit{Alternifolia}}{\text{Tlv Tlv alv alv}}$

F_1 hybrids : $\frac{\textit{Normal-leaved}}{\text{Tlv tlv Alv alv}}$ (bi-pinnate compound)

The F_2 frequencies were :

	Normal-leaved	Alterni-folia	Tiny-leaved
Observed ..	113	62	65
Expected on a 9: 3: 4 ratio	135	45	60

$X^2 = 10{\cdot}40$ P between 0·001 to 0·01. The fit is good.

The F_3 segregation was of the following order :

The results obtained in the F_3 generation cited above confirm the F_2 findings proving the dominance of the *Normal-leaved* plant, which in its homozygous state could, therefore, be symbolized as Slv Slv Tlv Tlv Nlv Glv Glv Alv Alv, thus comprising of at least five pairs of factors.

Grateful thanks are due to Dr. S. Solomon, Deputy Director of Agriculture (Crop Research), Bombay State, Poona, for the very keen interest evinced by him in the above study.

Crop Res. Section, G. P. Argikar.
Poona-5, *December* 28, 1957.

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TRACHEAL CONCENTRATION IN THE ABDOMEN OF TWO SPECIES OF COLEOPTERA

In recent years considerable attention is paid to the morphology of the respiratory system of insects because of its great physiological significance. Amongst the more recent and notable contributions are those of Keilin[1] and Whitten.[2-4] Whitten[2] first noted the close association of the nervous concentration and the tracheal displacement in Cyclorrhaphus Diptera. I have shown elsewhere (Tonapi[5]) that such a displacement does not occur in the Hymenopteran adults. The ventral commissures of Hymenoptera retain their segmental disposition even when the ganglia of their segments are forwardly displaced. A similar tracheal displacement has also been noted by me for the first time in the abdomen of two adult Coleoptera. In *Holotricha serrata* Fabr., it is possible to recognise three metameric tracheal components

in the abdomen: (*a*) lateral abdominal trachea, (*b*) spiracular trachea, and (*c*) the dorsal branch or anastomosis. Ventral commissures are absent. Visceral tracheæ are highly irregular in their distribution. These as well as the dorsal branches have a number of large and small vesicles. In addition to the above elements, there is a ventral tracheal concentration (Fig. 1). These ventral abdominal tracheæ

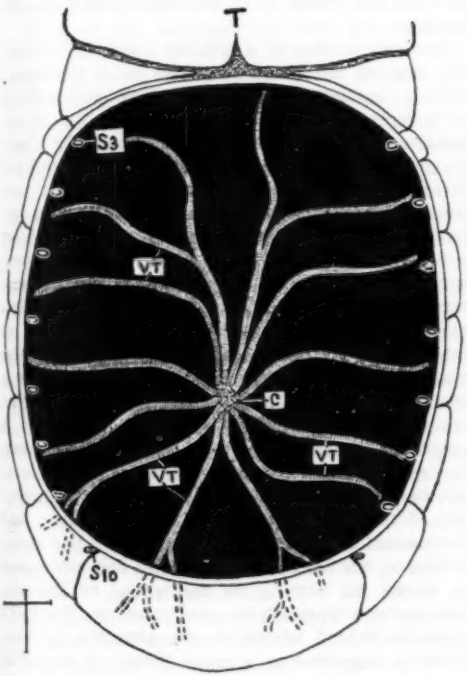

FIG. 1. Ventral tracheal system of the abdomen of *Hydroptila serrata* Fab. (Diagrammatic). Lateral abdominal tracheæ, spiracular tracheæ and dorsal branches are not shown. C = Place of tracheal concentration. VT = Ventral trachea. S = Spiracle. T = Metathorax.

are given off in each segment by the lateral abdominal tracheæ. They converge ventrally in the fourth segment and are devoid of any saccular dilatation. Absence of the ventral commissures and presence of such concentration instead suggests that they are comparable and are probably homologous.

In *Oryctes rhinoceros* L., a typical metameric element consists of (*a*) lateral abdominal trachea, (*b*) spiracular trachea, (*c*) a dorsal branch or anastomosis, and (*d*) a ventral commissure. The visceral elements are highly irregular. There is an enormous development of large and small vesicles. In addition to the above elements, there is a ventral tracheal concentration. It is interesting to note that the tracheal concentration is dorsal to the ventral commissures which, however, retain their segmental disposition.

In both cases referred to above, the ventral tracheal concentration is on the sternites. But it is not yet clear if this displacement is due to the ventral nerve cord as in Cyclorrhaphus Diptera. Since the scheme of tracheal distribution differs markedly in both the species, it is not possible to elucidate the homologies at this stage. Further studies are in progress and will be reported later.

I am grateful to the Ministry of Education, Government of India, for the award of a National Research Fellowship. I am indebted to Dr. S. P. Agharkar, Director, Maharashtra Association for the Cultivation of Science Laboratory, for facilities and encouragement.

M.A.C.S. Laboratory, G. T. TONAPI.
Law College Buildings,
Poona-4, *February* 17, 1958.

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REVIEWS

Water Waves. (*Pure and Applied Mathematics*, Vol. IV.) By J. J. Stoker. (Published by the Interscience Publishers, Inc., N.Y., India: Asia Publishing House, Bombay-1), 1957. Pp. xxviii + 567. Price $ 12.00.

In attempting to assess the position of Einstein's theory of gravitation today, J. L. Synge expressed the opinion (*Advancement of Science*, Vol. 14, No. 55, Dec. 1957, p. 207), that as matters stand at present, one may look forward to a good hundred years of work before a mastery over Einstein's theory is achieved. To justify this statement, he pointed out that it took about two centuries for the mathematical physicists to gain a thorough mastery over Newtonian theory, and indicated further that they are still working hard at it, mentioning as one instance, the theory of water waves which, in his opinion, is still far from complete.

The book under review which deals with flows in water exclusively on the basis of the classical hydrodynamics of non-viscous and incompressible fluids brings out clearly in what sense one can consider the theory of water waves as still being far from complete. In the very first chapter on basic hydrodynamics, the surface wave problem is formulated in all thoroughness, and it is indicated how difficult it is to solve it consequent on its non-linear nature, on the facts that the free surface is not known *a priori* and that the boundary varies with the time, and lastly on the circumstance that any mathematical formulation which would fit with observation even for a limited time would necessitate postulating the existence of singularities of unknown location, both in space and time. In view of these it is pointed out that the solution of problems in the full non-linear version of the theory will, for a long time to come, continue to be of the nature of existence theorems for motions of rather a special nature.

The great merit of the book however lies in showing, that in spite of the mathematical difficulties inherent in the general problem, it is possible to obtain results of real physical interest, highly significant for practical applications, by building up a suitable approximate theory. Nearly 95% of the book deals with two such approximate theories based respectively on the assumptions of small wave amplitudes, and small depth of liquid relative to the wavelength in both cases. It is worthy of note that two such simple and reasonable approximations should lead to the possibility of discussing a great variety of problems relating to phenomena of everyday occurrence in nature. In fact, this book is a veritable mine of information on topics connected with water waves, and it would be no exaggeration to say that it is perhaps the finest book on this subject so far written.

In a sense, this is a difficult book to review, for, one of the main functions of a reviewer, *viz.*, to indicate briefly the nature and extent of several parts of the book and of the problems dealt therein has been admirably performed by the author himself in the beautiful introduction to the book. It is rarely that one comes across a book like this in which the introduction serves the purpose of describing precisely what the book purports to achieve, thus making it easy for a reader with some knowledge of hydrodynamics to pick out immediately the particular topic in which he is interested, without wandering throughout the book. Apart from the introduction, the book itself can be considered as a model of clear, simple and rigorous scientific exposition. A reasonable balance has been achieved between the mathematics and the physics of the several problems treated, and a clear distinction maintained between physical assumptions and mathematical deductions. The author has mentioned in the introduction that he has attempted to model his writing on the works of Darwin, Huxley and Tyndall, in particular on Tyndall's book on Sound which, in the author's opinion, is to be regarded as a great classic of scientific exposition. We venture to predict that this book under review will also remain a classic on the subject for a long time to come, although its contents may come to be superseded by later researches.

Some of the striking physical problems dealt with are those relating to waves on sloping beaches and against vertical cliffs; ship waves and motion of a ship including wave patterns created by a moving ship; motion resulting from the breaking of a dam, the breaking of waves in shallow water, and the problem of the solitary wave; meteorological applications connected with cyclonic disturbances; and the theory of tides in the oceans and oscillations in lakes and harbours. The most interesting part of the book is the long Chapter Eleven on the subject of Mathematical Hydraulics dealing with

numerous problems relating to flows and wave motions in rivers and open channels. A particular topic treated in this chapter which is bound to be of vital interest to hydraulic engineers in India is the one which deals with floods in rivers and prediction of floods. There is a lot of empirical work on this subject done by our civil engineers which is perhaps not always based on exact scientific methods, and we would therefore specially like to bring this chapter to the notice of such workers.

Even on the mathematical side, the book has many surprises to offer. The first approximation of small wave amplitudes reduces the problem to the usual potential theory based on Laplace's equation, but special types of problems lead to the existence of mixed boundary conditions (*i.e.*, of ϕ and $\delta\phi/\delta n$) which even at this late date have generally been neglected. Again, it is curious to find that gravity wave problems, solutions of which satisfy Laplace's equation should require, for uniqueness, conditions at infinity of the radiation type that occur in Sommerfeld's diffraction problem. The second approximation of small depth brings out the unexpected result that, although one is dealing here with an incompressible non-viscous fluid theory, the non-linear partial differential equations along with the modified surface conditions are analogous to the equations of motion of compressible gases, even including phenomena analogous to the occurrence of shock waves in gas dynamics. Lastly, we have another unexpected result that some problems of the general theory (without either of the two approximations) could be solved by using the Lagrangian representation rather than the Eulerian representation of fluid mechanics.

The book is excellently printed, and contains beautiful figures and photographs, and a valuable bibliography of recent literature on the subject. In the summary prefacing Part II of the book, it is mentioned in the last paragraph on p. 36 that an Appendix to this Part containing a brief report of some of the more recent literature is given at the end of the Part, but we have searched in vain to find such an Appendix. We have mentioned this fact just because it is an important function of a reviewer to search for lacunæ, however trivial, and point them out.

In conclusion, we would like to repeat that this is a most beautiful book, and can well be considered a classic on the mathematical theory of wave motion in liquids, and its applications.

B. S. Madhava Rao.

Crystal Structures. (*Loose Leaves with Binders*, Supplement III to Chapters I-VIII.) By R. W. G. Wyckoff. (Interscience Publishers, New York; India: Asia Publishing House, Bombay-1), 1958. Price $ 20.00.

This well-known work of Prof. Wyckoff has been published in loose leaf form and comprises of five volumes. The first three of these contain data for Inorganic Compounds, while the fourth and fifth is devoted to Organic Compounds. The entire material is presented under fifteen chapters. Supplements have appeared from time to time and instructions have been given for filling the material properly, in correct places and making up the volumes. The present instalment called Supplement III consists of additional sheets to go into Chapters I-VIII. These accordingly go into Volumes I and II.

In this supplement, data for new compounds and data based on recent determinations and re-examinations of several of the older compounds have been presented, with relevant discussions, tables and illustrations. References have been extended up to the year 1955 (from 1949 to 1955).

The results of study of a large number of rare earth metals radioactive and transuranic elements and several polymorphic transformations are given. Further, low temperature crystallography has in recent years marked a notable progress. One, therefore, finds structure determinations at low temperatures reported and discussed, *e.g.*, solid chlorine, hydrogen cyanide, hydrogen peroxide, pentaborane, etc.

Numerous illustrations form the bulk of this Supplement, and with the addition of these the Volumes I and II comprising (I-VIII) chapters have been greatly enriched in their contents and usefulness.

As regards this publication, it is a treasure-house of information, invaluable to students of crystallography, crystal physics and crystal chemistry.

The Rolling of Strip, Sheet and Plate. By Eustace C. Larke. (Chapman & Hall, Ltd.), 1957. Pp. xi + 404. Price 63 *sh.*

In bringing out this book, the author has performed a very valuable service to students of metallurgical engineering and also to those concerned with rolling mill design and practice. The book deals with fundamentals of design and operation of rolling mills and

important investigations in this field. The author's expert knowledge of the subject has also augmented the subject-matter of the book.

The first two chapters describe various rolling plants including the modern Sendzimir and planetary roll mills making generous use of photographs of operating rolling plants. The next two chapters discuss design and production of roll camber and causes and control of gauge variation. Chapter Five discusses various factors affecting the rolling load such as rate of deformation, front and back tensions, etc., without going into the rigorous derivation for the roll separating force based on the theory of plasticity. The following chapters deal mainly with practical application of the principles and include the design of rational rolling schedule to ensure maximum production, the calculation of the hot and cold rolling loads, the effect of front and back tensions, various factors affecting the mean rate of deformation and the mean resistance to deformation in hot rolling.

The last three chapters are devoted to the calculations of energy consumed, horsepower developed in cold and hot rolling and factors affecting the productivity of strip mills, *viz.*, the handling time, weight and length of coil, etc.

Thus the first few chapters are devoted to design principles and the remaining to their practical applications. To emphasize the practical aspects, numerous worked-out examples are included and will be of great use to students.

The book is profusely illustrated with photographs, graphs, tables and worked examples, and a large list of references is also given at the end. These will help the reader considerably. Apart from an occasional printing error, the book is well presented.

R. C. DESHPANDE.

Lipids, Their Chemistry and Biochemistry, Vol. III. By Harry J. Deuel, Jr. (Published by Interscience Publishers, Inc., New York and London; India: Asia Publishing House, Bombay-1), 1957. Pp. xxxvi + 1065. Price $ 25.00.

Prof. Deuel had initially planned on writing one book on lipids, but very soon it became clear to him that it had to be split into two volumes: Vol. I, Chemistry; and Vol. II, Biochemistry. With progress of time he had to revise his plans still further and split the Biochemistry part into two volumes: Vol. II, Biochemistry (digestion, absorption, transport and storage); and Vol. III, Biochemistry (biosynthesis, oxidation, metabolism and nutritional value). This volume (Vol. III) completes the series.

The present volume has kept up the excellent tradition of the earlier ones by the same author. The exhaustive treatments of the chapters on biosynthesis, oxidation and metabolism of triglycerides will be most useful to students of biochemistry. Some of the most fascinating and rapidly developing fields of biochemistry have been very ably summarised in these chapters. The chapters on metabolism of cholesterol, carotenoids and of vitamin A also will be found equally profitable. Those on essential fatty acids and nutritional value of fats are extremely informative and timely and the classical controversy over the comparative nutritive values of butter and margarine between the Wisconsin School and Deuel himself will be read with great interest. Prof. Deuel had long practical experience, and has made significant contributions, in all these fields and the reviewer cannot think of a more suitable person that could do better justice to these topics.

A cursory glance through the three formidable volumes would leave one rather overwhelmed, as only wide experience, clear knowledge, hard work, drive, energy and confidence can lead one to undertake such a stupendous task and Deuel had all of them. All the three volumes are neatly arranged and exhaustively written in clear language. Collection of literature is probably complete. All universities, research institutions and other places of learning will feel compelled to procure all of them, as nowhere else so comprehensive collection of literature will be found, and the individual workers will only wish that they were little cheaper, as all three of them together will cost almost a fortune.

J. GANGULY.

Dry Battery Receivers with Miniature Valves. By E. Rodenhuis. (Philips Technical Library; India: Philips Elec. Co., 7, Justice Chandra Mehtab Road, Calcutta), 1957. Pp. viii + 240. Price 32 *sh.* 6 d.

The book begins with a brief introduction to the development of modern battery valves and battery receivers. The greatest drain on the energy source which has only a limited life in battery-operated receivers is to be attributed to the greater current consumption by the filament. In evolving suitable tubes for battery operation, this consideration weighed heavily on

the design. The successful culmination of tube design, whose filament current consumption was considerably low (150 mA, 50 mA and even 25 mA) depended on many-sided development. Three requirements had to be laid down to ensure this, (i) the tungsten wire had to be drawn very fine, (ii) the emissive coating had to be very thin, (iii) and the space between filament and grid had to be reduced in order to maintain the mutual conductance.

It has been possible to draw very fine tungsten wire (of the order of 10 μ) which were cataphoretically coated with a very thin layer of barium. With the realisation of these three requirements Philips have brought out the so-called "D" series valves. The modern battery receivers fall into three groups: (1) Portable receivers, (2) Battery/mains receivers, and (3) Domestic receivers, and in the Philips list of tubes one could choose tubes to suit any of the above-mentioned applications. In the book under review, complete data and characteristics for twelve of these are given. The applications of these tubes and practical circuits in which they are used, are elaborately discussed. The material presented fall under six chapters. Chapter I: Introduction; Chapter II: Miniature Battery Valves with 50 mA Filament; Chapter III: Electronic Tuning Indicators, DM 70 and DM 71; Chapter IV: Miniature Battery Valves with 25 mA Filament; Chapter V: Problems of Dry Battery Valve Supply; and Chapter VI: Circuit Considerations. Seven circuits which have been actually constructed and tested are given in the last chapter using Philips valves, complete with circuit diagrams and component values.

In Chapter V a very useful discussion of the problems that arise in connecting the filaments in series or in parallel according to the type of receiver is given. The book provides complete technical data and characteristics of dry battery receiver tubes and contains highly useful discussions, invaluable to the hobbist, who is interested in constructing his own set, or to the service engineer or to designers. Unfortunately, however, a few mistakes have crept into the book which are of a minor nature and it is hoped that these would be rectified in later editions.

A. J.

Insect Flight. By J. W. S. Pringle. (Cambridge University Press), 1957. Pp. vii + 132. Price 15 *sh.*

During the course of evolution, Nature has several times attempted to solve the problem of flight. The birds, bats and insects are notable achievements of these attempts, with a few lesser known examples. Of them again, the birds and insects are the two groups where mechanisms of flight have been developed to a high degree. Among the Aves the flight mechanisms are similar throughout the group while in *Insecta* they offer a great variety of structural and physiological modifications which makes flight in this group a truly amazing phenomenon. In comparison with the insect, the bird is ungainly, clumsy and crude, unable to execute the almost incredible feats of the former,—rapid starts, astonishing change of direction and even backward flight. If our knowledge of insect flight has not advanced as much as that of the birds, it is largely because of the small size of insects as well as the great variety and complexity of the mechanisms, which involve a number of extremely tiny structures disposed in intricate designs.

It is clear that the disciplines needed for the understanding and elucidation of insect flight are at once diverse and exacting, and it is not surprising that our knowledge of it is of recent development, gained during the past 10-15 years. All the others, like Magnan's book *Le Vol des Insectes* (1934), are of historical value. This is because much of the physics and mathematics of flight is itself of recent origin, and this knowledge has contributed measurably to a clearer and more competent appreciation of the variety as well as the intricacy of insect flight mechanisms. Consequently, the advances being made each year are so striking and spectacular that frequent reviews seem necessary.

J. W. S. Pringle's book is one such review, and a very competent one, bringing together most of our knowledge of the diverse problems associated with insect flight. Much of the general anatomy of the wings and wing-bearing segments is known for a long time from the classical studies of Snodgrass and others. But the kinematics, the relation between histology, physiology and biochemistry of flight muscles and aerodynamics are problems of the most absorbing interest and Dr. Pringle has put together the available information, so as not only to indicate the progress made in these fields but also to present, in outline, the directions of future research. Specially important in this connection is the development in higher insects,—Diptera, Hymenoptera and Coleoptera,—of a peculiar type of flight muscle, the fibrillar muscle, which is responsible for the wonderful feats of high frequency movement in these insects, and the like of which is never met with anywhere else.

It has been possible to present here an analysis of the enzymatic activity, metabolic rate and oxygen consumption in this muscle, and all evidence points to its being a highly unique structure whose evolution in the group should be of absorbing interest.

A chapter on nervous and sensory mechanisms deals with the extent of our knowledge of the control of flight. Even here, the factors involved are so many and so diverse that we are only just beginning to understand some of them. For instance, there must be different sensory and nervous mechanisms for flight initiation and flight maintenance. In a number of insects, flight initiation is now known to be specific reflex action, the so-called "Tarsal reflex" of Fraenkel but the maintenance of flight is governed by an entirely different set of factors and stimuli one of which Weis-Fogh calls "wind on the moving wings". But it should be emphasised that neither flight initiation nor its maintenance is due to the same factors in all insects and it is quite possible that even here, an evolutionary trend could be discerned among them.

Insect Flight is invaluable to all students of entomology as well as those who are interested in the physiology and physics of movement in the air.

B. R. S.

A School Course of Biology. Fourth Edition. By L. J. F. Brimble. (Publishers: Macmillan & Co., Ltd., London), 1957. Pp. xv + 558. Price 18 *sh.*

Mr. Brimble is well known for his many books on biology, social science and general education. *A School Course of Biology* is written to meet the requirements of candidates of General Certificate of Education (Ordinary Level) in Great Britain. For the Fourth Edition, the author has secured the collaboration of Dr. Kramer, a senior biology master, who is also "well known for his work in connexion with the teaching of biology and with its social applications".

The book contains 20 chapters: each chapter is followed by questions and very useful "suggestions for practical, observational, experimental and field work" for the student. The treatment of the subject is very simple and lucid. Many of the recent biological findings are incorporated in the text. Mention may be made of the simple autoradiograph on page 163. The last chapter, man in relation to other living organisms, is devoted towards the economic aspects of biology of everyday nature, such as, food crops, beverages, medicines, textiles, timber and animals (for food, leather and drugs). It is very informative for the beginner. References are also made to insecticides, biological control of pests, microbiology, viruses and animal husbandry.

The statement on page 528 that among the algæ there are no parasites is erroneous, for it is known that *Rhodochytrium* and *Phyllosiphon* among Chlorophyceæ, and *Harveyella* and *Choreocolax* among Rhodophyceæ are undoubted parasites accompanied by loss of photosynthetic pigments. Cassava (p. 501) appears in italics and the student will mistake it for the Latin name, as the other Latin names in the same chapter are printed in italics. There is a printer's devil on page 36: it ought to be *mono-tremes* and not *mono*-tremes. On page 103, reference to the same page is superfluous. There is no uniformity with regard to the magnifications of figures. For some magnifications are given and for a majority of the others magnifications are not given. While the line drawings are effectively reproduced, half tones are not very clear, for the paper used is not suitable for fine reproduction of the latter.

Mr. Brimble must be congratulated for producing one of the best text-books of biology in the United Kingdom. The book is got up well with end papers depicting "evolution of organisms". The price is within the reach of the student. With slight elaboration of individual life-histories of plants the book may be recommended for pre-University course in biology in India.

R. NARAYANA.

Books Received

The Invertebrata. Third Edition. By G. A. Kerkut, L. A. Borradaile and F. A. Potts. (Cambridge University Press, London N.W. 1), 1958. Pp. xvii + 795. Price 55 *sh.*

An Introduction to Statistics for the Social Science. Second Edition. By T. G. Connolly and W. Sluckin. (Cleaver-Hume Press, London W. 8), 1957. Pp. vii + 166. Price 16 *sh.*

Combination of Observations. By W. M. Smart. (Cambridge University Press), 1958. Pp. xi + 253. Price 35 *sh.*

Surface Active Agents and Detergents, Vol. II. By A. M. Schwartz, J. W. Perry and Julian Berch. (Interscience Publishers, N.Y.), 1958. Pp. xv + 839. Price $ 17.50.

Film Formation, Film Properties and Film Deterioration. By Charles R. Bragdon. (Interscience Publishers, N.Y.), 1958. Pp. xv + 422. Price $ 9.75.

SCIENCE NOTES AND NEWS

Lobed Leaf-Mutant in Blackgram (*Phaseolus mungo*, Linn.)

Blackgram usually has large trifoliate leaves. Divakaran and Ramabhadran report an interesting deviation from the normal leaf character observed in blackgram grown under rain-fed conditions in the black soil block of Agricultural Research Station, Kovilpatti. One single plant, in selection No. 212 received from the Millets and Pulses Specialist, Coimbatore, was found to have three lobes instead of the normal trifoliate leaves. But for this peculiarity, the plant conformed to *Phaseolus mungo*, Linn., in description. Though occurrence of lobed leaf in greengram has been recorded it is not reported in blackgram. The inheritance and ontogeny of the character are being pursued.

X-Ray Analysis of Rare Earths

The Bureau of Mines has developed a simple and accurate method for making quantitative analyses of rare earth ores, metals and compounds, using X-ray emission spectroscopy. With the new technique, 40 samples a day can be analysed for seven elements each, whereas, with the methods formerly used, only about a dozen samples could be analysed in a week.

The method is described in Bureau of Mines Report of Investigations R.I. 5378, "X-Ray Emission Spectrographic Analysis of Bastnaesite Rare Earths".

Super Powerful Microscope

This is one of the new types of super powerful microscopes designed by Soviet scientists and engineers. They have a magnifying power of over one million.

The electronic projector resembles a television electronic tube. It has a glass retort with a spherical or flat bottom which serves as a screen.

Inside the retort is a fine metal needle directed towards the screen. The latter serves as the projector's negative electric pole. When a current of several thousand volts is passed through the needle, it emits electrons. Bombarding the screen, they produce on it a greatly magnified picture of the needle point and of the particles on it.

If a small quantity of gas is allowed to enter the retort, the molecules settle on the inner walls and the needle. A molecule "sitting" on the needle is, so to speak, an additional protrusion which appears on the screen immensely magnified. No instrument has ever had such great magnifying power.

Metal surfaces can be observed and studied with the help of the new device. The scientist has to make only the needle of the required metal, and microscopes of one or even two million-fold magnifying power will make it possible for him to study the crystalline structure of the metal. The new instrument can be used to observe and study molecules of many substances such as, for instance, antrocene, oxygen, etc.—*Soviet News.*

Ultraviolet Color-Translating Microscope—New Tool for Studying Anatomy of Living Systems

This paper reports initial results with the ultraviolet color-translating microscope, a new instrument which uses a combination of sequential color television and ultraviolet microspectrophotometric techniques. A brief discussion of the operation is given (V. K. Zworykin and F. L. Hatke, *Science*, 126, 805, 1957). In the instrument the specimen is illuminated sequentially by three selected wavelengths in the ultraviolet or visible and the image reproduced on a color television receiver. The minimum bandwidth in the present instrument is 5 mμ, which permits the differentiation of small absorption shifts in the specimen. The ultraviolet dosage to the specimen is kept to a minimum by ultrafractioning the light into approximately 1-msec. bursts, 1/60 sec. apart. There is evidence to indicate that such intermittent illumination reduces radiation damage to the specimen. Previous methods of examining living tissue required photography or a continuous illumination using an ultraviolet-sensitive Vidicon. The reduced ultraviolet dosage using a special image Orthicon has permitted the continuous observation of such specimens as tissue cultures, muscle fibres, and connective tissues for periods which would previously have caused rapid necrosis and death.

In addition to color photographs of living unfixed specimens, motion pictures showing initial successful application to the study of amœboid cells, Kupfer cells, capillary circulation, mast cells, and other elements in connective tissues in the mesentery, all in the living

state, are shown. Some suggestions for the development of improved optics were made.—*Science*, December 1957, p. 1237.

Chemical Aeronomy

The chemical structure of the earth's atmosphere is primarily a result of the action of solar radiation on the atmospheric gases. The study of the chemical reactions between the various atmospheric constituents has been designated "chemical aeronomy", and the region of the atmosphere where these reactions are most prevalent is called the "chemosphere". Nitric oxide is present in the upper region of the chemosphere. Its concentration is determined by the relative rates of the reactions between atomic nitrogen and molecular oxygen and between atomic nitrogen and nitric oxide. Many of the aeronomic chemical reactions produce the luminous emission of the night airglow. The atomic lines and molecular bands of the airglow indicate, what chemical reactions are taking place and what are the physical conditions at the level of emission. The Herzberg and atmospheric bands of oxygen, which are prominent airglow emissions, have been produced and studied in Laboratory afterglows. Some still unidentified airglow emissions have also been obtained in Laboratory sources. The technique of artificially producing an airglow by rocket seeding experiments makes possible the detection of some of the atmospheric constituents and suggests as well, a method of measuring the temperature of the upper atmosphere.—*Science*, December 1957, p. 1232.

Melting of Metals in a State of Contactless Suspension

A new high frequency installation to melt metal in a state of contactless suspension in a high frequency electromagnetic alternating field, without a crucible, has been designed at the high frequency electrothermic laboratory of the Metallurgy Institute, the USSR Academy of Sciences.

The melting techniques used until now caused molten metal to combine with the material of the crucible. In the new installation metal is under the pressure of the electromagnetic field which counterbalances its weight. Transformed into a liquid, metal continues to "suspend" until it is poured out, absolutely free from foreign substances, into a mould.

The new melting method offers a possibility of studying such chemically active metals as zirconium, titanium, vanadium and their alloys.

The production of rare metals in a pure state is important for the manufacture of modern technical equipment which has these metals as its ingredients.

Particle Size Distribution by Centrifugal Sedimentation

Physical properties which may be used for characterization of thorium oxide are of special interest and must be determined. One of these properties which is related to the hydrodynamic behaviour of the slurries, is the size distribution of the particles.

Mr. Menis and colleagues of the Oak Ridge Laboratory, U.S.A., have developed a cumulative centrifugal sedimentation method applicable to determining the particle size distribution of thorium oxide in the particle size range of 0·1 to 2·0 microns in diameter. By selection of suitable operating conditions it is possible to accomplish sedimentation in small, cylindrical-shaped cells in 25 minutes or less. Under these selected conditions of sedimentation—detailed in report ORNL-2345—the particle size distribution can be obtained from the cumulative sedimentation data by applying either Oden's method of tangential intercepts or a function plot method. Results by this centrifugal method correlate with results obtained by different gravitational sedimentation methods for the portion of sample composed of particles greater than 2 microns in diameter.

Antarctica is a Continent

Antarctica has always correctly been called a continent. This much has been shown by the preliminary results of the profile studies carried out by the Trans-Antarctic party under Dr. Fuchs: so far as that part of Antarctica covered by the party is concerned, the whole of the land beneath the ice cap is above sea-level.

The party made seismic and complementary gravimetric studies at frequent intervals along its 2,200 miles traverse. Until this scientific inquiry, it could not be taken for certain that Antarctica was continuous land: it could well have been series of islands cemented by its ice. From the recordings made, Mr. Geocrey Pratt is now able to say: "There is nothing below sea-level anywhere."

He said the continental profile studies showed, there were no mountains in the interior to compare with those in the McMurdo area. The mountain chains identified beneath the ice cap were "humps" by comparison. The general level of the underlying land on the McMurdo side of the Pole was much higher than on the

Weddell Sea side. One mountain system below the interior ice cap was only about 1,500 ft. under ice, Mr. Pratt said. Here the land was at 7,000 ft. making the surface 8,500 ft. This was the area about 50 miles south of Depot 700 where bad crevassing had been found. Crevasses in the interior usually sign posted mountain tops not far below.

Mr. Pratt spoke of the huge trough in the land beneath the ice of the South Pole. The shape of the continent, with huge "bites" opposite each other at the Ross and Weddell Seas, suggested that if anywhere there were a chasm below sea-level splitting Antarctica in two, it would be along this line. From the studies made by the crossing party this possibility may now be discounted.

Until the party reached the Pole, the seismic shots were made at about every 30 miles; beyond the Pole at about 60 miles. Gravimetric recordings were done about every 15 miles throughout.

Symposium on the Chemistry of Co-ordination Compounds

A Symposium on the Chemistry of Co-ordination Compounds will be held in December 1958, under the auspices of the National Academy of Sciences. The Symposium will be divided into the following sections: (1) General Survey; (2) Valence Bond Considerations, Stereochemistry and Structure; (3) Techniques and Methods of Investigation; (4) Reactions, Stability and Thermodynamic Considerations; (5) Stabilisation of Valence States; (6) Use in Analytical Chemistry; and (7) Applications. Further particulars can be had from Arun K. Dey, Assistant Professor of Chemistry, University of Allahabad, Allahabad.

The Indian Society for Plant Physiology

The Inaugural Meeting of the Society was held on the 24th of January 1958, in the University of Allahabad, when the Constitution of the Society was adopted and the following Office-bearers for 1958 were elected: *President*: Prof. P. Parija, Vice-Chancellor, Utkal University, Cuttack; *Vice-Presidents*: Shri Boshi Sen, Director, Vivekananda Laboratory, Almora; Prof. Shri Ranjan, Vice-Chancellor, Allahabad University, Allahabad; Dr. J. C. Sengupta, Chief Botanist, Botanical Survey of India, Calcutta; *Honorary Secretary*: Dr. J. J. Chinoy, Reader in Botany, University of Delhi, Delhi-8; *Honorary Treasurer*: Dr. K. K. Nanda, Lecturer in Botany, University of Delhi, Delhi-8.

Award of Research Degree

Messrs. B. T. Lingappa and Yamuna Lingappa were awarded the Ph.D. Degree by the Purdue University, Lafayette, Indiana, for their work on "Cytology of Development, Sexuality and Host Reactions of *Synchytrium Brownii* Karling and *Physoderma pulposum* (Wallr.) Karling respectively.

Messrs. V. Sundara Murthy, B. Radhakrishna Murthy, and Chengalvala Venkata Ratnam of the Osmania University, Hyderabad-Dn., were awarded the Ph.D. Degree in Chemistry for their theses entitled "Search for Physiologically Active Compounds: Synthesis of Some Halo and Nitro Coumarins"; "Studies on Groundnut-Shell Hemicelluloses" and "Studies in the Formation of Hetrocyclic Rings from Ophenylene Diamines and Aromatic Aldehydes" respectively.

The Andhra University has awarded the D.Sc. Degree in Physics to the following candidates for their thesis indicated against each: Shri V. Suryanarayana, "Spectroscopic Investigations on Some Disubstituted Benzenes"; Shri S. L. N. G. Krishnamachari, "Calculation of Force Constants of Certain Polyatomic Molecules and Investigations on the Raman Effect, Infrared and Ultra-violet Absorption of Fluorinated Disubstituted Benzenes"; Shri P. B. V. Haranath, "Band Spectra of the Halogens (X_2, X_2, X_2^+)"; Shri Ch. Radhakrishnamurthy, "Studies in Dielectrics at Microwave and Radio Frequencies"; Shri K. V. Gopalakrishna, "Dipole Moment Calculations of Some Tetra Substituted Benzenes and Investigations on Dipole Moments and Relaxation Times at Microwave Frequencies".

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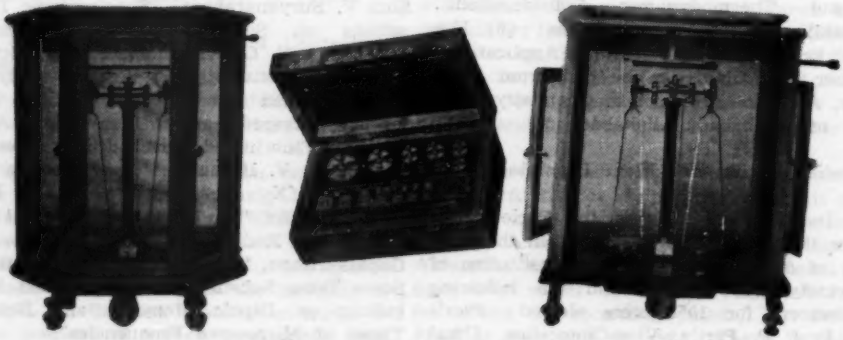

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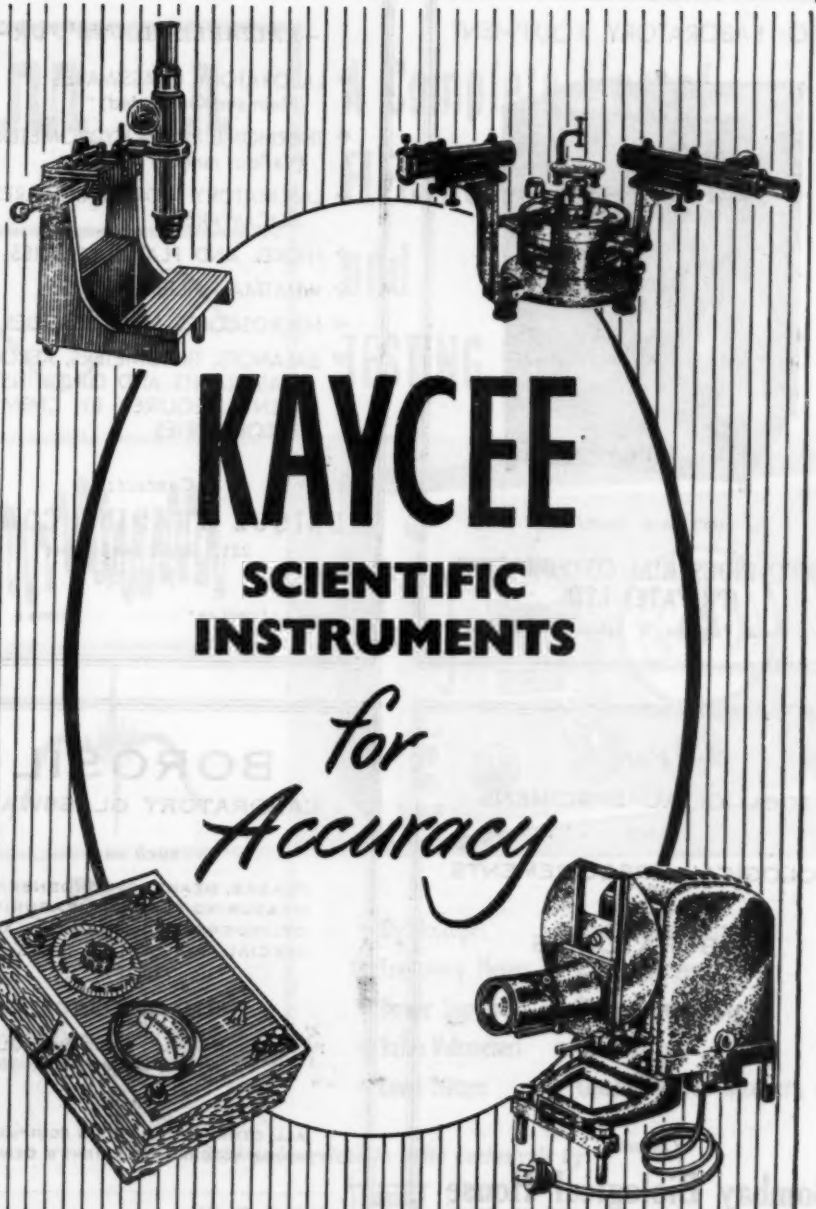

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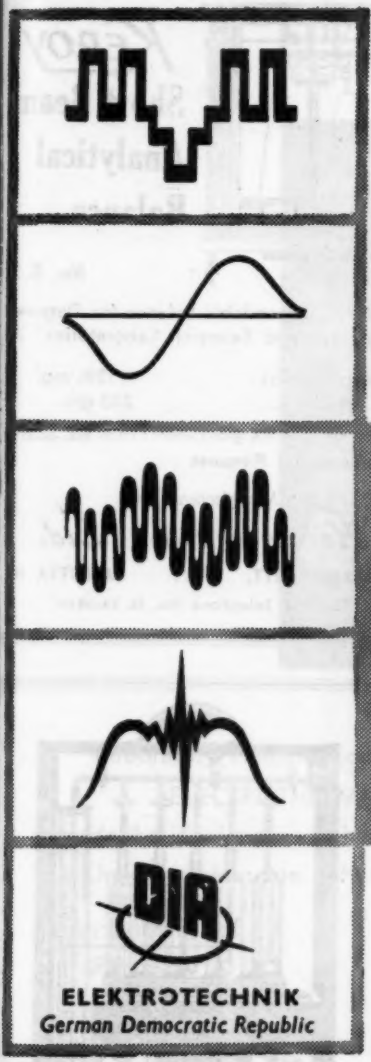

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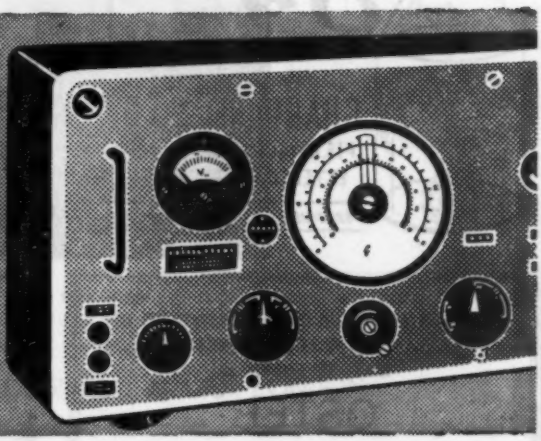

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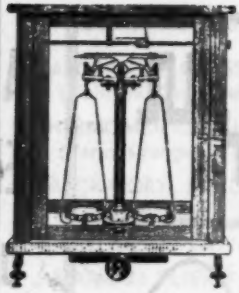

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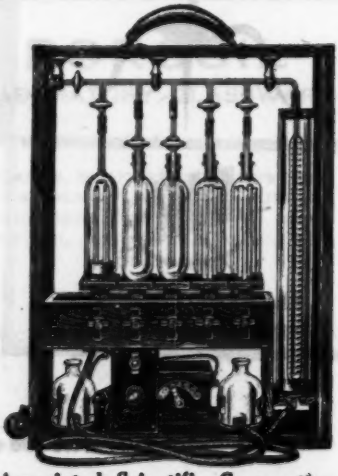

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